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1 INTRODUCTION

This documents covers the operation and maintenance of the Ceiba FFD Multiphase pump system including operation and maintenance of the following items:

- Subsea (Framo Dual Pump Station - FDS)
  - Multiphase Pump
  - Multiphase Flow Meter
  - By-pass valve
  - Re-circulation choke
- Topside (Power and Control Module - PCM)
  - Barrier Fluid HPU
  - Control Fluid HPU
  - VSD

Operation and maintenance of topside power generation system should be carried out according to 4553-1028-D.

Correct operation of the Ceiba FFD subsea multiphase booster pumps is critical for optimised well production, and also important for safe operation of the pumps. This document describes operation of the pumps and auxiliary system. This document applies for operation of the Framo Multiphase Pumps located on C1, C5 and C8(CC) on the Ceiba-field.

1.1 Reference Documents and Drawings

For detailed information, maintenance and troubleshooting, a number of documents and drawings may be required. Some operation requirements also refer to other documents listed below.

Operation and Maintenance Manuals, Commissioning Procedures

4553-1400-D	SW User Manual – HMI System Ceiba FFD
4553-0763-D	Control System Graphical User Interface
4553-1021-D	C1 Start up procedure
4553-1022-D	C5 Start up procedure
4553-1023-D	CC Start up procedure
4553-1027-D	FRAMO FFD Pump System – Topside equipment Maintenance Manual
4553-1028-D	M75 Systems Operation Manual
4553-1210-D	C1 Pump System Commissioning Procedure
4553-1211-D	C5 Pump System Commissioning Procedure
4553-1212-D	CC Pump System Commissioning Procedure
4553-1304-D	PCS and LV&MCC Cabinet Operator Manual
4553-1305-D	PCS Cabinet - E300 Operator Manual
6246-0048-D	Subsea Phasewatcher VX Installation and Retrieval Guidelines
6246-0040-D	Subsea Phasewatcher VX On Site Commissioning Procedure
3AJG000305/338/345-840	VSD Frequency Converter, Firmware Manual
3AJG000305/338/345-841	VSD Frequency Converter, Hardware Manual
3AJG000305/338/345-842	VSD Frequency Converter, Diode Supply Unit, User's Manual
3AJG000305/338/345-843	VSD Water Cooling Section, User's Manual
3AJG000305/338/345-844	VSD Bender Earth Fault Monitoring Unit, User's Manual
3AJG000305/338/345-845	VSD Control Section, AC80 User's Manual
3AJG000305/338/345-846	VSD Frequency Converter, Step-Up / Sine filter for ACS600, User's Guide
3AJG000305/338/345-847	VSD Topside Transformers, User's Manual
3AJG000305/338/345-848	VSD Megacon, User's Manual

Framo Engineering Drawings, Process

4553-0064-1	Ceiba C1 Location Dual pump station P&ID
4553-0063-1	Ceiba C5 Location Dual pump station P&ID
4553-0065-1	Ceiba CC Location Dual pump station P&ID
4553-0313-1	Hydraulic Schematic Barrier Fluid HPU C1 Ceiba FFD
4553-0314-1	Hydraulic Schematic Barrier Fluid HPU C5 Ceiba FFD
4553-0315-1	Hydraulic Schematic Barrier Fluid HPU C8 Ceiba FFD
4553-0319-1	Hydraulic Schematic Control Fluid HPU C1 Ceiba FFD
4553-0320-1	Hydraulic Schematic Control Fluid HPU C5 Ceiba FFD
4553-0321-1	Hydraulic Schematic Control Fluid HPU C8 Ceiba FFD
4553-0068-2	Ceiba FFD Utility Systems C1 Hydraulic and instrument
4553-0770-2	Ceiba FFD Utility Systems C5 Hydraulic and instrument
4553-0771-2	Ceiba FFD Utility Systems CC Hydraulic and instrument
4553-0224-3	Valve Control POD Schematic-Pod
4553-0048-1	FDS, Subsea Control System Schematic
4553-0060-D	Basis for Operation and Control
4553-0615-D	Barrier fluid system
4553-0618-D	Methanol System – Calculations
7636 CEIBAFFD/FE/AMHE/006	Methanol distribution
4553-0616-D	Operation of Choke and Control Valve
4539-0667-1	Hydraulic Schematic HPU Work Over Systems

Framo Engineering Drawings, Electrical

4553-0454-3	LOOP DIAGRAM C1/C5/CC _TT002 AND _PT003
4553-0455-3	LOOP DIAGRAM C1/C5/CC _PT001 AND _PT006
4553-0456-3	LOOP DIAGRAM C1/C5/CC _PT004A, _PT004B AND _TT005
4553-0457-3	LOOP DIAGRAM C1/C5/CC _TT007 AND _PT008
4553-0458-3	LOOP DIAGRAM C1/C5/CC _PT009A, _PT009B AND _TT010
4553-0459-3	LOOP DIAGRAM C1/C5/CC _PT011 AND _ZT016
4553-0460-3	LOOP DIAGRAM C1/C5/CC _XV012, _XV013 AND _XV017
4553-0461-3	LOOP DIAGRAM C1/C5/CC _XV014 AND _XV015
4553-0462-3	LOOP DIAGRAM C1/C5/CC _UT023
4553-1164-3	PUMP CONTROL – WELL CONTROL PROFIBUS CONNECTION
4553-0596-3	TERMINATION DRAWING INTERFACE CABLE CAMERON WCS TO FE PLC C1
4553-1374-3	TERMINATION DRAWING INTERFACE CABLE CAMERON WCS TO FE PLC C5
4553-1375-3	TERMINATION DRAWING INTERFACE CABLE CAMERON WCS TO FE PLC C8
4553-0597-3	TERMINATION DRAWING SS INSTRUMENTATION 19-CX-J002
4553-0598-3	TERMINATION DIAGRAM SS SOLENOIDS 19-CX-J004
4553-0599-3	TERMINATION DRAWING SS MODEM 19-CX-J005
4553-0601-3	TERMINATION DRAWING SS INSTRUMENTATION 19-CX-J003
4553-0346-1	SINGLE LINE DIAGRAM 6,6KV
4553-0347-1	SINGLE LINE DIAGRAM 440V
4553-0348-1	SINGLE LINE DIAGRAM 230V
4553-0349-1	SINGLE LINE DIAGRAM 230V UPS
4553-0064-1	P&ID C1 LOCATION
4553-0319-1	HYDRAULIC SCHEMATIC CONTROL FLUID C1
4553-0313-1	HYDRAULIC SCHEMATIC BARRIER FLUID C1
4553-0322-1	HYDRAULIC CIRCUIT DIAGRAM CONTROL FLUID C1
4553-0330-1	HYDRAULIC SCHEMATIC W/UMBILICAL C1
4553-0237-1	SUBSEA CONTROL SYSTEM WIRING DIAGRAM
6246-0033-3	INTERNAL WIRING DIAGRAM FOR SS PW VX
4553-0489-1	CONTROL INTERFACE DRAWING TOPSIDE
4553-0494-D	CONTROL SYSTEM CABLE LIST
4553-1346-3	WIRING DIAGRAM ESD SHUTDOWN UPS BATTERIES
4553-0241-D	PUMP CONTROL SYSTEM ALARM & TRIP SCHEDULE
4553-0242-D	PUMP CONTROL SYSTEM PLC I-O LIST
4553-0244-D	CAUSE & EFFECT DIAGRAMS PCS
4553-0245-D	CAUSE & EFFECT DIAGRAMS PCS
4553-0246-D	CAUSE & EFFECT DIAGRAMS PCS
4553-0247-D	CAUSE & EFFECT DIAGRAMS PCS
4553-0248-D	CAUSE & EFFECT DIAGRAMS PCS
4553-0370-D	OVERALL BLOCKDIAGRAM CONTROL SYSTEM
4553-0478-3	TERMINATION DRAWING BARRIER FLUID HPU ANALOG
4553-0479-3	TERMINATION DRAWING BARRIER FLUID HPU DIGITAL
4553-0480-3	TERMINATION DRAWING CONTROL FLUID HPU ANALOG
4553-0481-3	TERMINATION DRAWING CONTROL FLUID HPU DIGITAL

Mongstad Elektro Drawings PCS Cabinet

ME2892	INTERNAL LAYOUT LV/MCC CABINET sheet 1
ME2893	INTERNAL LAYOUT PCS CABINET sheet 1
ME2888	ITEM LIST LV/MCC CABINET sheet 1-3
ME2889	ITEM LIST PCS CABINET sheet 1-3
ME2986	CABLE LIST LV/MCC CABINET sheet 1-3
ME2887	CABLE LIST PCS CABINET sheet 1-4
ME2884	CABLE WIRING DIAGRAM LV/MCC CABINET sheet 1-5
ME2885	CABLE WIRING DIAGRAM PCS CABINET sheet 1-17
ME2890	INTERNAL WIRING LV/MCC CABINET sheet 1-17
ME2891	INTERNAL WIRING PCS CABINET sheet 1-23
ME2880	INSTRUMENT SUBSEA INTERFACE JBX 002 sheet 1-3
ME2881	INSTRUMENT SUBSEA INTERFACE JBX 003 sheet 1-4
ME2882	SOLENOID SUBSEA INTERFACE JB 004 sheet 1-4
ME2883	FLOWMETER JBX 005 sheet 1-4

Sicom Drawings

P397-ATN-001 SCO-AI FA 001	TERMINATION DIAGRAM TOPSIDE
P397-ATN-001 SCO-AI FA 002	TERMINATION DIAGRAM SUBSEA
P397-ATZ-001	CONSI MDU User Manual

1.2 Safety/Special requirements

All operation and maintenance described in this manual shall only be carried out by skilled/trained personnel.

All work on live or pressurised systems, requires trained and skilled personnel, authorised for this work.

All personnel shall be familiar with emergency escape routes, first aid and use of fire fighting equipment.

All working areas shall be kept clean and tidy at all times. Any oil or chemical spillage shall be cleaned up immediately.

All work on HV systems shall be coordinated and supervised by FPSO responsible electrician. Prior to work on electrical circuits, feeders shall be locked in open position.

1.3 Assistance from vendor

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NORWAY

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Telephone (24 hours): +47 90 99 00 06
Fax: +47 55 99 92 90

1.4 Abbreviations

C&E	-	Cause and effect
DHPT	-	Downhole Pressure and Temperature
FAQ	-	Frequently Asked Questions
FE	-	Framo Engineering AS
FMS	-	Frank Mohn Services AS
FPSO	-	Floating Production Storage and Offloading Vessel
HMI	-	Human to Machine Interface (same as OS)
MeOH	-	Methanol
MPV	-	Manifold Pigging Valve
OS	-	Operator Station (same as HMI)
PCR	-	Process Control Room
PCS	-	Pump Control System
PLC	-	Programmable Logic Controller
PMV	-	Production Master Valve
PT	-	Pressure Transmitter
PWV	-	Production Wing Valve
SCSSV	-	Surface Controlled Subsurface Safety Valve
SP	-	Set Point
TT	-	Temperature Transmitter

2 SYSTEM

2.1 Process and Operating Conditions

The subsea multiphase pump is designed to be able to give the produced fluid from C1, C5 and CC a pressure increase of up to 40 bar (580psi). It is assumed that the static reservoir pressure is sufficient to bring the liquid level above the pump module elevation.

The methanol and scale-inhibitor is the same for the multiphase pump system as for any other piping subsea, with one exception: The recycle line in the module is not insulated and special attention must therefore be given related to hydrate formation. This is described in this manual.

The alarm- and trip settings reflect the design process conditions. They should not be changed without consultation with FE.

2.2 Barrier Oil System

Purpose: The barrier oil system shall protect the MPP internal mechanical parts from ingress of process fluid, and at the same time protect the electrical motor from sea water ingress. The oil is also cooling the motor.

Oiltype: Shell Morlina VG5

Cleanliness: min. NAS class 6 and a maximum water content of 100 ppm.

Operation: The barrier oil system is preset to a certain level above the process pressure. The barrier oil system shall at all times be activated, even if the pump is not in operation (i.e. shall never be switched off). By monitoring/trending the barrier oil operational parameters(oil consumption), the MPP mechanical integrity can be analysed.

2.3 Control Valve System

Purpose: The system supplies hydraulic power to the re-circulation valve (V4) and the by-pass valve (V3 or V7) actuators for valve operation.

Oil type: OCEANIC HW 525

Cleanliness: Min. NAS class 6

2.4 Control System

The Pump Control System comprises a Mitsubishi Q series PLC, a control and interface cabinet, and subsea interface junction boxes, located in the PCM topside. The operator's normal interface is a PC LabView application in the Process Control Room (PCR). A separate manual is made for this application (4553-XXXX-D HMI User Manual).

For detailed operator instructions, see Framo doc. 4553-1304-D 'PCS and LV&MCC Cabinet Operator Manual' and 4553-1305-D 'PCS Cabinet - E300 Operator manual'.

For detailed operator instructions for the PCR HMI station, see Framo document 4553-1400-D HMI User Manual. See also chapter 14.5 for FAQ.

The LabView application comprises 27 main pictures for the different parts of the Ceiba FFD Multiphase Pump System.

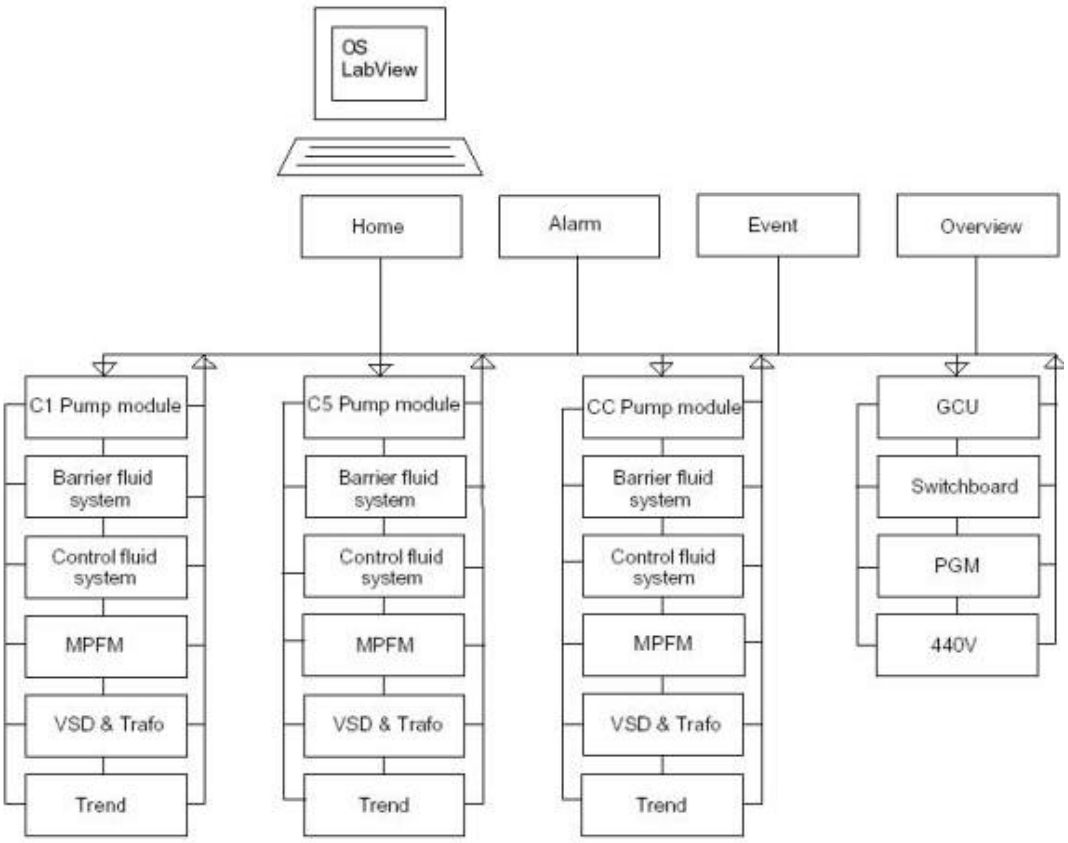


Figure 2-1. LabView hierarchy

Common screens

Picture no.	Figure no.	Description
1	Figure 16-2 Figure 16-3	Home screen
2	Figure 16-4	Overview.
3	Figure 16-5	System overview (not shown in hierarchy)
4	Figure 16-6	Alarm list
5	Figure 16-7	Event list

Pump System Screens (C1, C5 and CC/C8)

Picture no.	Figure no.			Description
	C1	C5	CC/C8	
6-12-18	Figure 16-8 Figure 16-9	Figure 16-14 Figure 16-15	Figure 16-20 Figure 16-21 Figure 16-22 Figure 16-23 Figure 16-24 Figure 16-25	Pump Module CX with pop-up menus
7-13-19	Figure 16-10	Figure 16-16	Figure 16-26	Barrier fluid system CX
8-14-20	Figure 16-11	Figure 16-17	Figure 16-27	Control fluid system CX
9-15-21	Figure 16-12	Figure 16-18	Figure 16-28	VSD & Trafo CX
10-16-22 (A)	Figure 16-13	Figure 16-19	Figure 16-29	MPFM CX, Manifold layout.
10-16-22 (B)			Figure 16-30	MPFM CX, Trend layout.
11-17-23 (A)			Figure 16-31	Trend CX, Historical data.
11-17-23 (B)			Figure 16-32 Figure 16-33 Figure 16-34	Trend CX, Real time data with pop up menus.

Topside Power System

Picture no.	Figure no.	Description
24	Figure 16-35	GCU
25	Figure 16-36	PGM1
26	Figure 16-37	High Voltage Switch Board.
27	Figure 16-38	400 Voltage distribution

The pictures are shown in section 16.

2.5 Electrical Systems

The PCM electrical systems comprises the VSD for C1, C5 and CC, including topside and subsea transformers, and frequency converters. A 440V power supply and 230V UPS from shipboard switchgear systems, supply the PCM Utility and Control Systems.

2.5.1 VSD System

The PCM VSD system comprises one common step down transformer for the two frequency converters, one common AC80 control cabinet, and two step up transformers. For troubleshooting and maintenance reference is made to the following ABB documents (C1/C5/C8):

3AJG000305/338/345-840	VSD Frequency Converter, Firmware Manual
3AJG000305/338/345-841	VSD Frequency Converter, Hardware Manual
3AJG000305/338/345-842	VSD Frequency Converter, Diode Supply Unit, User's Manual
3AJG000305/338/345-843	VSD Water Cooling Section, User's Manual
3AJG000305/338/345-844	VSD Bender Earth Fault Monitoring Unit, User's Manual
3AJG000305/338/345-845	VSD Control Section, AC80 User's Manual
3AJG000305/338/345-846	VSD Frequency Converter, Step-Up / Sine filter for ACS600, User's Guide
3AJG000305/338/345-847	VSD Topside Transformers, User's Manual
3AJG000305/338/345-848	VSD Megacon, User's Manual

2.5.2 230V / 440V Power System

The shipboard 440V system supplies the PCM with normal power.

For detailed operator instructions, see Framo doc. 4553-1304-D ‘PCS and LV&MCC Cabinet Operator Manual’.

230 V For detailed operator instructions, see Framo doc. 4553-1304-D ‘PCS and LV&MCC Cabinet Operator Manual’ and 4553-1305-D ‘PCS Cabinet - E300 Operator manual’.

2.5.3 230V UPS and Normal Power Systems

230V UPS is supplied from the shipboard UPS, and supplies the PLC, all topsides and subsea instruments, and VSD control system.

The 230V normal power distribution in the PCM, comes from a 440/230V internal transformer, located under the PCM raised data floor. 230V normal power is used for lighting, socket outlets and MCC control voltage.

For further details, see document listed in section 2.5.2.

3 OPERATIONAL PHILOSOPHY

3.1 General

The following operation and control philosophy provides a basis for the operating procedures and the control system specification.

1. The pump control system is a stand-alone system with minimum of interfaces to other systems.

2. Monitoring and control of the pump system including all auxiliaries are through a PLC located in the PCM. The primary HMI that communicates with the PLC is an operator station located in the PCR.

3. The pump control system PLC and HMI has the following functions:

    - Control and monitor the HVAC system
    - Control and monitor the barrier fluid HPU system
    - Control and monitor the valve control fluid HPU system
    - Control and monitor the Framo VSD
    - Control and monitor all FDS actuated control valves and chokes
    - Communicate permissive to start, permissive to run, alarm and trip signals to the Framo VSD
    - Communicate trip signals to the feeder in the Framo GCM step-down transformer
    - Communicate trip signals to the Cameron WCS (one hardwired permissive from each well)
    - Communicate trip signals to the ABB DCS (one hardwired permissive)
    - Communicate with the MPFM flow computer
    - Monitor all FDS instruments ex. MPFM
    - Monitor GCM step-down transformer
    - Monitor VSD step-up transformer
    - Monitor FDS step-down transformer
    - Monitor Cameron well, x-mas tree and manifold pressure, temperature and valves positions.

4. Operation of the pumps (start, stop and change in operating point) is performed by manual step-by-step procedures allowing safe operation at all intermediate stages without any time critical constraints.

5. The pumps can only be started in by-pass mode.

6. The two pumps in each FDS can be operated individually one at the time or simultaneously. If both pumps are used they are started and stopped simultaneously and have identical speed reference.

7. If one pump is running the other pump is only allowed to start when the pumps are in by-pass mode. Likewise a pump can be stopped in by-pass mode with the other pump running.

8. The pumps should normally be started on natural flowing wells before any wells that are not flowing naturally are routed through the pumps.

9. When a pump stop/shut down is initiated, the pumps should immediately be set in by-pass mode. If both pumps are stopped, this will cause a trip signal to Cameron WCS.

10. Following a pump stop the re-circulation loop should immediately be filled with methanol. For a prolonged pump shut-down the whole FDS should be filled with methanol.

11. If a well that is being pumped is closed in, the re-circulation choke and by-pass should immediately open. If the well is the last well open this will also cause a pump trip.

12. The pump operator can change the operating point by adjusting the pump speed or the opening of the re-circulation choke.

13. Based on the producing wells, a totalised GVF is calculated at the pump inlet conditions. This GVF together with pump speed is used to calculate the maximum differential pressure the pump can produce for the given conditions. The system will provide alarm and trip if maximum differential pressure is exceeded.

14. A set of conditions will define permissive to start. The control system will not allow start-up of the pumps unless these conditions are satisfied.

15. A set of conditions will define permissive to run. The control system will provide alarm outputs if the borderline of these conditions are approached or eventually trip the pumps if these conditions are not satisfied.

16. Some of the conditions defining the pump envelope and permissive to run requires knowledge of the actual fluid properties and gas volume fraction at pump suction conditions. These parameters may be given as manual inputs or computed by the control system based on well test data and the actual wells that are pumped.

3.2 Guidelines for operation

Since the properties of each well is different and the well characteristics changes over time, it is not possible to stat exact speed and re-circulation valve setting for each location. The operator has to define these setting prior to a start up. The guidelines given in this section should give the operator knowledge to define the start up settings.

#	Description	Explanation	Reference / Value
3.2.1	Number of wells to be produced?	C5 and CC have both the possibility to connect 4 wells, C1 only one.	
3.2.2	Are any of the wells producing naturally?	Define which wells that are producing naturally or not. Wells flow naturally to be started first. Wells that are not producing naturally to be started one by one after the naturally producing wells are started. A flowing well can be recognised by a increase in wellhead temperature after the well is opened and production to topside separator. If a non-producing well needs “heavy” kick-starting, it can be convenient to stat this well first and open the other wells one by one afterwards.	
3.2.3	Are any of the wells not producing naturally?		
3.2.4	Hess to define maximum draw down of bottom hole pressure for each well with max/min tolerances.	Well A: Draw down:_____psi Tolerances: ±____psi Well B: Draw down:_____psi Tolerances: ±____psi Well C: Draw down:_____psi Tolerances: ±____psi Well D: Draw down:_____psi Tolerances: ±____psi	

#	Description	Explanation	Reference / Value
3.2.5	Define flow rate at pump inlet conditions for the wells that are producing naturally.	Pump suction: Suction pressure:_____bara Temperature:_____°C Flowrate:_____m^3/hr	
3.2.6	For C5; define if one or two pumps shall be started based on natural production rated and estimated flow rate with target draw down (or based on earlier experience).	B:_____ A&B:_____	
3.2.7	Based on natural production flow rate select start speed and re-circle valve position.	A start speed giving an inlet flow rate corresponding to the natural production flow rate shall be selected. When the pump is started and the bypass is closed the pump shall operate at a low differential pressure. For C1 and CC the re-circle valve shall be between 48 and 50 % open to get permissive to start. For C5 the re-circle valve position is dependent on if one or two pumps are started. With one pump the re-circle valve position shall be between 48 – 50 % and with two pumps above 95 % to get permissive to start.	
3.2.8	Producing wells shall prior to pump start up be opened to allowed flow rate, pressure and temperature to stabilize. Be patient to allow any gas cap at wellhead to escape through flow line.	The pumps ability to generate differential pressure on pure gas is limited. A gas slug (gas cap) entering the pump suction may cause the pump to go into surge or trip on low differential pressure.	
3.2.9	If no wells are producing naturally at a location, non-producing wells shall prior to pump start up be opened to allowed flow rate, pressure and temperature to stabilize. Be patient to allow any gas cap at wellhead to escape through flow line.	The pumps ability to generate differential pressure on gas is limited. A gas slug (gas cap) entering the pump suction may cause the pump to go into surge or trip on low differential pressure. A gas filled pump module will have limited possibility to draw down suction pressure to kick-start a non-flowing well. In this case, where the pump is only re-circling through the re-circle loop, the gas is trapped inside the module.	

#	Description	Explanation	Reference / Value
3.2.10	If no wells are producing naturally at a location, estimated liquid level in flow line based on pump suction or discharge pressure, topside pressure, fluid densities and water depth at current location. Liquid level in flow line must be above pump module. If not, fill up flow line with diesel oil. Water level: C1: 700 m C5: 810 m CC: 785 m 1 bara = 14.5 psia 1 bara = 0 barg °C=(°F-32°)*5/9	Pump pressure:_____bara Topside pressure:_____psi (before choke) Liquid density:_____kg/m^3 Gas density:_____kg/m^3 **Formula to calculated liquid level!!**	
3.2.11	Define if the well is producing pure liquid.	A flowing well is assumed to produce some gas. A non-flowing well shall be assumed to produce pure liquid. When selecting a pump speed above 2000 rpm the operator will have to confirm that the pump are not operating one pure liquid. On pure liquid a differential pressure above **TBD** bar is expected for one pump in operation with 50% re-circle valve setting and above **TBD** bar is expected with two pumps in operation with 100 % re-circle valve setting.	
3.2.12	Adjusting speed or re-circle valve to increase differential pressure.	For speeds below 3000 rpm it is preferable to increase speed to increase differential pressure. Above 3000 rpm it is preferable to close re-circle valve to increase differential pressure. The re-circle valve should not be less than 15 % open. Pump inlet conditions can be stabilized by opening the re-circle valve for a pump connected to an unstable well.	

#	Description	Explanation	Reference / Value
3.2.13	Change operating point of pump with constant suction pressure.	The pump operating point can be moved right in the pump performance envelope by opening the re- circ. valve and increasing the speed in steps (open re-circ. valve before increasing speed!). Likewise, the pump operating point can be moved left in the pump performance envelope by reducing speed and closing the re-circ. valve in steps (reduce speed before closing re-circ. valve!). With small steps a constant suction pressure can be maintained.	
3.2.14	Stable / unstable well production	Recycling more fluid through the recycling line can stabilize an unstable well. In principle can a stable well be operated with closed re-circulation valve. But it is recommended to keep the re-circ valve somewhat open after a well start up to gain experience.	
3.2.15			

4 PERMISSIVE TO START

4.1 Permissive to start

The permissive to start the pump are listed in the table shown below.

Tag.no	Text	Description
19-CX-UI1100	Barrier fluid HPU in operation	The barrier oil system is shown in Figure 16-10. The barrier oil system supplies pressure topside from a HPU located in the PCM. The controls/switches are also located in the PCM. Ref chapter 2.2.
19-CX-UI1150	Control fluid HPU in operation	The control fluid system is shown in Figure 16-11. The system supplies pressure topside from a HPU located in the PCM. The controls/switches are also located in the PCM. Ref chapter 2.3
19-CX-UI1300A or 19-CX-UI1300B	HVAC unit 1 or 2 available	The HVAC unit 1 and 2 are located topside in the PCM. There are 2x70% capacity and at least one of them has to be available in order to get permissive to start the pump.
19-CX-UI1200A 19-CX-UI1200B	VSD ready	The variable speed drive and the trafo's are shown in Figure 16-18. They are located topside in the PCM.
18-CX-UI072 or 18-CX-UI073 or 18-CX-UI074 or 18-CX-UI075	Permissive from Cameron WCS	There is one permissive from each well. The permissive is a common signal from Cameron that all valves for a well is open to the inlet of the FDS. To have permissive to start the pumps at least one well must be open.
18-CX-UI022	Permissive from ABB DCS	The permissive are that all valves topside leading to a separator are open.
TBD	Bypass valve V3/V7 position open	Operated from a pop-up window that pops up when clicking <u>once</u> on the valve in Figure 16-14, pop-up menu shown in Figure 16-15.
TBD	Recycle valve V4 position open	One pump: 48 – 50% Two pumps:> 95% The valve could either be set to a

Tag.no	Text	Description
		percentage value or stepped step by step. There are 134 steps from open to close.
-	No active trips or alarms	All trip and alarm has to be acknowledged to get permissive to start. No LED indicator in Operate POP-UP menu is showing this!
NA	All process and barrier parameters within normal range	A process parameter that is outside normal range will cause an alarm/trip until it is within his normal range.
-	Ready to start	All the permissive above has to be OK to get ready to start.

4.2 Permissive to run

The permissive to run are listed in the pop-up windows shown below.

Tag.no	Text	Description
18-CX-UI072 or 18-CX-UI073 or 18-CX-UI074 or 18-CX-UI075	Permissive from Cameron WCS	There is one permissive from each well. The permissive is a common signal from Cameron that all valves are open from the well to the inlet of the FDS. To have permissive to run the pumps, at least one well must be open (one permissive from Cameron WCS). If the permissive from one pump is lost, the by-pass valve will open and the pump speed will be reduced to 2000 rpm.
18-CX-UI022	Permissive from ABB DCS	The permissive are that all valves topside leading to the separator are open.
-	No trips	Any pump system parameter exceeding the trip limit (lowlow or highhigh) will cause a pump trip.

It should be noted that the pumps can be running even if the barrier fluid HPU and control fluid HPU is out of operation. The pump will only stop if the barrier pressure vs. process pressure is below the trip level. Low supply pressure of the control fluid will not cause a pump trip but it will be impossible to operate the bypass valve (V3), re-circulation valve (V4) and methanol injection valves (V8 & V9).

5 ACTION LIST PRIOR TO START UP

Before any pump is started the following activities should be performed:

<table>
<tr><th>#</th><th>Description</th><th>Reference / Value</th></tr>
<tr><td>5.1.1</td><td>Read the actual procedure before any actions is started.</td><td></td></tr>
<tr><td>5.1.2</td><td>Define number of wells to be started and clarify if the wells are producing natural or not.
<table>
<tr><th>Well id:</th><th>Naturally producing</th><th>Not naturally producing</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table></td><td></td></tr>
<tr><td>5.1.3</td><td>Hess to define maximum draw down of bottom hole pressure for each well with max/min tolerances.</td><td>Well _____:
Draw down:_____psi
Tolerances: ±____psi
Well _____:
Draw down:_____psi
Tolerances: ±____psi
Well _____:
Draw down:_____psi
Tolerances: ±____psi
Well _____:
Draw down:_____psi
Tolerances: ±____psi</td></tr>
</table>

<table>
<tr><th>#</th><th>Description</th><th>Reference / Value</th></tr>
<tr><td>5.1.4</td><td colspan="2">Estimate production flow rate for wells that are producing natural (if not possible to estimate well by well, set all wells equal, the dPmax calculation is base on the GVF):
<table>
<tr><td rowspan="2">Well id:</td><td colspan="3">Flow rate at P and T</td><td rowspan="2">Temperature
[°C]</td><td rowspan="2">Pressure
[bara]</td><td rowspan="2">GVF
[%]</td></tr>
<tr><td>Qoil
[m^3/hr]</td><td>Qwater
[m^3/hr]</td><td>Qgas
[m^3/hr]</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>5.1.5</td><td>If no wells are producing naturally at a location, estimated liquid level in flow line based on pump suction or discharge pressure, topside pressure, fluid densities and water level at current location.

Water level:
C1: 700 m
C5: 810 m
CC: 785 m

Formula to calculated liquid level!!</td><td>Pump pressure:_____bara
Topside pressure:_____psi (before choke)
Liquid density:_____kg/m^3
Gas density:_____kg/m^3

Liquid level:_____m (above pump modul)</td></tr>
<tr><td>5.1.6</td><td>Based on natural production flow rate, estimated production flow rate at target draw down or experience for earlier, select if one or two pumps are to be started.</td><td>One or two pumps.</td></tr>
<tr><td>5.1.7</td><td>Based on natural production flow rate calculate the pump speed that correspond to the natural production flow rate.</td><td>Speed:_____rpm</td></tr>
<tr><td>5.1.8</td><td></td><td></td></tr>
</table>

6 START UP OF PUMP

6.1 Start-up of pump with wells that are flowing naturally

This procedure gives a step-by-step procedure to start up wells that are producing natural.

Criteria's:
Pump system is ready to start.

#	Description	Reference / Value
6.1.1	Read the procedure from top to bottom before any action in started.	
6.1.2	Check that barrier fluid system is in operation.	
6.1.3	Check that control fluid system is in operation	
6.1.4	Check that HVAC is in operation	
6.1.5	Check that VSD is ready to start	
6.1.6	For C1 check that barrier pressure is regulated according to wellhead pressure or discharge pressure whichever is highest before the well is opened.	
6.1.7	Hess should decide current max. draw-down and down hole pressure. Also the minimum allowable time to reach the draw down should be given. Target DHP should be above minimum DHP in case of fluctuations. Alarm-limits on the down hole pressure should be set on the Cameron PC in the PCR (Typical Target ±10 psi) to notify the operator in the PCR to adjust pump settings Wells connected: Location / C1 / C5 / CC Well A / C1 / - / - Well B / NA / C10 / C8 Well C / NA / C5 / C19 Well D / NA / C13 / -	Well_____: Draw down:_____psi Tolerances: ±____psi Well_____: Draw down:_____psi Tolerances: ±____psi Well_____: Draw down:_____psi Tolerances: ±____psi Well_____: Draw down:_____psi Tolerances: ±____psi

#	Description	Reference / Value
6.1.8	Note the following:	

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

1 bara = 14.5 psia
1 bara = 0 barg
°C=(°F-32°)*5/9

6.1.9	Open wells that will produce natural according to Hess procedure.	
6.1.10	FPSO production system topside is prepared for production from the well. Check that the ABB screen is showing the same routing as the actual routing (M10, M11 or M10 test), i.e. ESD valves to the actual separator.	
6.1.11	Note the following:	

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

#	Description	Reference / Value
6.1.12	Let flow rates, pressures and temperatures stabilize for 1 hour (or until pressure and temperature have stabilized). Gas cap must be evacuated through flow line!	
6.1.13	Note the following:	

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

6.1.14	Estimate natural production flow rate including GVF.	Q:_____m^3/hr GVF:_____%
6.1.15	Update the flow data in the PLC for each well. If flow data for each well is not available, set all wells equal.	
6.1.16	Select if one or two pumps is to be started	A or B or, A and B
6.1.17	Check that by-pass is open	
6.1.18	Set re-circle valve in correct position; 48 – 50 % to start one pump >95 % to start two pumps	V4 position:_____%
6.1.19	Estimate pump speed corresponding pump inlet flow rate equal to the natural production flow rate.	Speed:_____rpm
6.1.20	Reset any trips or alarm from HMI system.	Reset
6.1.21	All requirements to achieve “Ready to start” in the FE HMI shall now be fulfilled.	Operate…
6.1.22	Start pump.	1500 rpm (automatically)

#	Description	Reference / Value
6.1.23	If two pumps are started, check that both pumps have "identical" differential head. If one is producing head and one is not, stop the pump that is producing head, wait until the pump running is producing head and restart the stopped pump. The reason for this problem is that one pump was initially filled with mostly gas and one with mostly liquid. This causes that the pump operating with gas goes into surge. Since the other pump closes the check valve at the outlet, the gas is trapped inside the pump	
6.1.24	Pump is now running in bypass mode at 1500 rpm	
6.1.25	Set speed to the speed estimated in 6.1.19. Confirm not pure liquid at 2000 rpm.	
6.1.26	Close by-pass valve. The pump differential pressure should now start to increase. If not, open by-pass valve again and increase speed with 250rpm and then close by-pass valve. Repeat if necessary	
6.1.27	Increase speed in steps of 50 rpm, adjust wellhead process choke if necessary to balance wells, until target draw down is reached for each individual well. At 3000 rpm, start to close re-circle valve also (one at the time). It is recommended to stabilise the DHP for at least 30 minutes pr. 40 psi drawdown. It will be necessary to choke some of the wells to achieve correct draw down for each well. Keep V4 at least 15% open! Note: Allow sufficient time for the production rate and FBHP/FWHP to stabilise, as the response to pump speed/choke position might be slow. DO NOT RUSH! Keep in mind draw down etc.	Typical values:

#	Description	Reference / Value
6.1.28	Current valve positions should now be: SCSSV1: Open PMV: Open PWV: Open Wellhead choke: >25% open (loss of permissive below 25%) V3/V7: Closed V4: >= 15%	
6.1.29	Note the following:	
6.1.30	The Pump is now in normal operation!	

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

6.2 Start-up of pump with well that is not flowing naturally

This procedure gives a step-by-step procedure to start up wells that are not producing natural.

Criteria's:
Pump system is ready to start.
Pump is by default started on pure liquid; maximum speed is 2000 rpm until operation on gas is confirmed.

<table>
<tr><th>#</th><th>Description</th><th>Reference / Value</th></tr>
<tr><td>6.2.1</td><td>Read the procedure from top to bottom before any action in started.</td><td></td></tr>
<tr><td>6.2.2</td><td>Check that barrier fluid system is in operation.</td><td></td></tr>
<tr><td>6.2.3</td><td>Check that control fluid system is in operation</td><td></td></tr>
<tr><td>6.2.4</td><td>Check that HVAC is in operation</td><td></td></tr>
<tr><td>6.2.5</td><td>Check that VSD is ready to start</td><td></td></tr>
<tr><td>6.2.6</td><td>For C1 check that barrier pressure is regulated according to wellhead pressure or discharge pressure whichever is highest before the well is opened.</td><td></td></tr>
<tr><td>6.2.7</td><td>Hess should decide current max. draw-down and down hole pressure. Also the minimum allowable time to reach the draw down should be given. Target DHP should be above minimum DHP in case of fluctuations.

Alarm-limits on the down hole pressure should be set on the Cameron PC in the PCR (Typical Target ±10 psi) to notify the operator in the PCR to adjust pump settings

Wells connected:
<table>
<tr><td>Location</td><td>C1</td><td>C5</td><td>CC</td></tr>
<tr><td>Well A</td><td>C1</td><td>-</td><td>-</td></tr>
<tr><td>Well B</td><td>NA</td><td>C10</td><td>C8</td></tr>
<tr><td>Well C</td><td>NA</td><td>C5</td><td>C19</td></tr>
<tr><td>Well D</td><td>NA</td><td>C13</td><td>-</td></tr>
</table></td><td>Well_____:
Draw down:_____psi
Tolerances: ±____psi
Well_____:
Draw down:_____psi
Tolerances: ±____psi
Well_____:
Draw down:_____psi
Tolerances: ±____psi
Well_____:
Draw down:_____psi
Tolerances: ±____psi</td></tr>
</table>

#	Description	Reference / Value

6.2.8 Note the following:

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

1 bara = 14.5 psia
1 bara = 0 barg
°C=(°F-32°)*5/9

6.2.9 Open wells that are not producing natural according to Hess procedure.

6.2.10 FPSO production system topside is prepared for production from the well.
Check that the ABB screen is showing the same routing as the actual routing (M10, M11 or M10 test), i.e. ESD valves to the actual separator.

6.2.11 Note the following:

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

#	Description	Reference / Value
6.2.12	Let pressures and temperatures stabilize for 1 hour (or until pressure and temperature have stabilized). Gas cap must be evacuated through flow line!	
6.2.13	Note the following:	

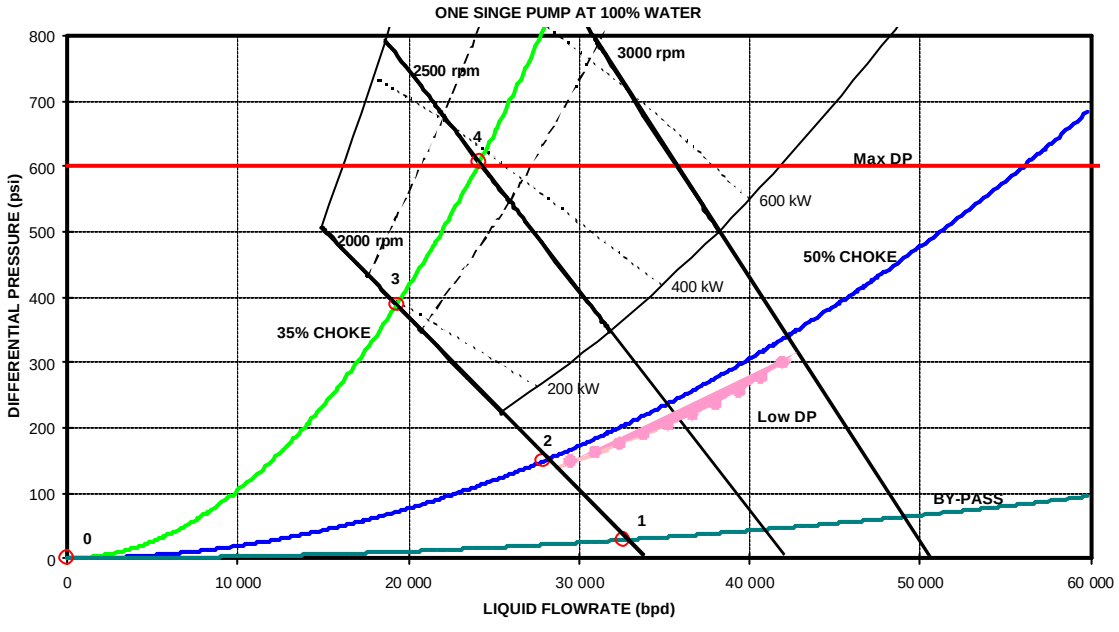
Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

6.2.14	Estimate liquid level in flow line based on pump suction pressure, topside pressure (before choke) and densities. Topside pressure:_____psi Water levels C1: 700 m C5: 810 m CC: 785 m Liquid level:_____m above Pump Modul	
6.2.15	Set flow data for each well in PLC to 1 m^3/hr of water (rest zero). This gives a GVF of 0%.	
6.2.16	Select if one or two pumps is to be started based on expected production flow rate at target draw down. Normally it is required to start only one pump!	A or B or, A and B
6.2.17	Check that by-pass is open	
6.2.18	Set re-circle valve in correct position; 50 % to start one pump 100 % to start two pumps	V4 position:_____%
6.2.19	Reset any trips or alarm from HMI system.	Reset

#	Description	Reference / Value
6.2.20	All requirements to achieve “Ready to start” in the FE HMI shall now be fulfilled.	Operate…
6.2.21	Start pump.	1500 rpm (automatically)
6.2.22	If two pumps are started, check that both pumps have “identical” differential head. If one is producing head and one is not, stop the pump that is producing head, wait until the pump running is producing head and restart the stopped pump. The reason for this problem is that one pump was initially filled with mostly gas and one with mostly liquid. This causes that the pump operating with gas goes into surge. Since the other pump closes the check valve at the outlet, the gas is trapped inside the pump	
6.2.23	Pump is now running in bypass mode at 1500 rpm	
6.2.24	Set speed to 2000.	
6.2.25	Close by-pass valve. The pump differential pressure should now start to increase. On pure liquid a differential pressure of 10 bar (150 psi) is expected for one pump in operation with 50% re-circle valve setting.	

CEIBA FFD - PUMP HYDRAULIC CHARACTERISTICS



#	Description	Reference / Value
6.2.26	Close re-circle valve in steps, adjust wellhead process choke if necessary to balance wells, until target draw down is reached for each individual well. It may not be possible to reach target draw down with the current speed but speed must be kept 2000 rpm until GVF>5% is confirmed. It is recommended to stabilise the DHP for at least 30 minutes pr. 40 psi drawdown. It will be necessary to choke some of the wells to achieve correct draw down for each well. Keep V4 at least 15% open! Note: Allow sufficient time for the production rate and FBHP/FWHP to stabilise, as the response to pump speed/choke position might be slow. DO NOT RUSH! Keep in mind draw down etc.	
6.2.27	When operation on gas is confirmed: Increase speed in steps of 50 rpm, adjust wellhead process choke if necessary to balance wells, until target draw down is reached for each individual well. It may be wise to open the re-circle valve and increase speed to get more stable operating conditions (one at the time).	
6.2.28	Current valve positions should now be: SCSSV1: Open PMV: Open PWV: Open Wellhead choke: >25% open (loss of permissive below 25%) V3/V7: Closed V4: >= 10%	

#	Description	Reference / Value
6.2.29	Note the following:	

Well					
Down hole pressure					bara
Wellhead pressure					bara
Wellhead temperature					°C
Wellhead choke position					%

Pump A suction pressure	PT001		bara
Pump A discharge pressure	PT003		bara
Pump A Process temperature	TT002		°C
Pump B suction pressure	PT006		bara
Pump B discharge pressure	PT008		bara
Pump B Process temperature	TT007		°C
Separator pressure	-		bara

6.2.30	The Pump is now in normal operation!	

7 NORMAL OPERATION

7.1 Normal operation of pump(s)

During normal operation the speed and/or the re-circulation choke position can be changed from the HMI system. Based on the well tests performed, chapter 0, the PLC calculates the GVF the pump(s) are operating at. The GVF and pump speed is then used to calculate the maximum allowable differential pressure over the pump(s). For most cases the maximum differential pressure is 40 bar but at high GVF or at low speed the dpmax limit can be lower than 40 bar. The maximum differential pressure is displayed as dPmax on the process screen in the HMI system. Based on the GVF, speed and Pump dP also the theoretical flow rate at the pump inlet is calculated.

Please not that the calculated GVF, dPmax and flow rate are based on historical well test data. To use this data for guidance for pump operation requires that the well test data's are updated regularly.

The basis for normal operation of the pump is to keep a constant down hole pressure for each well.

Criteria's:
Pumps started and in stable operation

#	Description	Reference / Value
7.1.1	In the HMI system the estimated GVF that the pump are operating is display. The GVF is based on the latest well test data stored in the PLC. Therefore, a change in flow conditions from one of the wells requires a new well test. **Do well testing regular to have correct flow data in the PLC for each well!!**	
7.1.2	Based on GVF from the well test data and speed, the dPMax is calculated. The dPmax value is displayed in the HMI system. The pump differential pressure should never be higher than the dPmax value! The dPmax value will be lower than the alarm limit for high differential pressure at low speeds and high GVF's! If the pump is operating close to the dPmax; open V4 and increase speed in steps to get higher margin to dPmax. Remember to keep constant suction pressure during this operation.	

7.1.3	The maximum operation speed of the pumps operating at single-phase liquid is set to 2000 rpm.	
7.1.4		

7.2 Starting up an additional well when the pump is running (only C5 and CC)

Both C5 and CC is connected to a manifold with 4 well connections. If one well has to be started after the pump is running the following procedure should be followed.

Criteria's:
At least 1 well in production
By-pass closed

#	Description	Reference / Value
7.2.1	Read the procedure from top to bottom before any action in started.	
7.2.2	Hess should decide current max. draw-down and tolerances Also the minimum allowable time to reach the draw down should be given. Target DHP should be above minimum DHP in case of fluctuations. Alarm-limits on the down hole pressure should be set on the Cameron PC in the PCR (Typical Target ±10 psi) to notify the operator in the PCR to adjust pump settings Wells connected:	Well_____: Draw down:_____psi Tolerances: ±____psi
7.2.3	Verify if the second pump has to be started to handle the new flow rate. A start up of the second pump requires bypass mode, a naturally producing well can then be restarted together with the other wells according to procedure 6.1. Start of the second pump is carried out according to 7.4.	
7.2.4	Updated flow data in PLC for the actual well. Use latest well test for a naturally producing well. For a not naturally producing well set Qwater to 1 m^3/hr and Qoil/Qgas to zero (this gives 0% GVF).	

Location	C1	C5	CC
Well A	C1	-	-
Well B	NA	C10	C8
Well C	NA	C5	C19
Well D	NA	C13	-

#	Description	Reference / Value
7.2.5	Route well to be started through MPFM by operating valves at Cameron manifold.	
7.2.6	Initiate well to be started on flow meter screen in HMI system. The HMI system will after 5 min. start to display online data from the flowmeter. Before the well is opened the flow rate should be zero.	
7.2.7	Check that pump suction pressure is lower than wellhead pressure. If not, close well choke of the other wells in steps and increase pump speed in steps to reduce suction pressure with constant downhole pressure for the flowing wells.	
7.2.8	When suction pressure is somewhat lower than the wellhead pressure, open the wellhead choke in steps and increase pump speed in steps to keep constant suction pressure until the target draw down is reached for the new well. Open the well choke very slowly to avoid to fast evacuation of the gas cap (if present). Use the flow meter to see that the well is starting to flow and to check the actual GVF. It might be necessary to draw down the suction pressure further to reach target downhole pressure for the new well. In this case, the wellhead choke on the other wells must be adjusted to keep the correct downhole pressure for these wells. Remember; always close wellhead choke before increasing speed and decrease speed before open wellhead choke in this step-by-step adjustment. Adjust V4 if required.	
7.2.9	When wellhead choke is 24 % open make a short well test to update the flow data in the PLC.	

#	Description	Reference / Value
7.2.10	When the wellhead choke is more than 25% open the pump control system will get a well permissive from Cameron. The PLC will then recalculate the GVF at pump inlet including the new well. Based on the new GVF a new dPmax will be calculated. Adjust V4 and/or speed if required	
7.2.11		

7.3 Shutting down a well when the pump is running (only C5 and CC).

Criteria's:
Two wells or more in production

#	Description	Reference / Value
7.3.1	Read the procedure from top to bottom before any action in started.	
7.3.2	If two pumps running, verify from well test and performance envelope if both pumps shall be running after the well is shut down. If not, shut down pump first and close well while pump is in bypass mode! A not naturally producing well may require that the well is closed before the pump is stopped Note: By-pass mode may require that not flowing wells are shut down and restarted.	
7.3.3	Reduce speed of pump in steps and close wellhead choke of well to be shut down in step to keep constant suction pressure. Adjust V4 if required!	
7.3.4	When wellhead choke is less than 25 % open, the well permissive from Cameron is lost. PLC will then recalculate GVF and dPmax. Adjust V4 and speed if required to satisfy the new operations conditions.	
7.3.5	Keep on with reducing speed and closing choke until the well is closed. Adjust V4 if required!	
7.3.6	Check if chokes on remaining wells can be open and pump differential pressure reduced after the well is closed. Reduce speed before open choke! Adjust V4 if required.	
7.3.7	Follow Cameron/Hess procedure to shut down well	

7.4 Start of second pump when first pump is running.

One pump can be started with one pump running only if the pump is in bypass mode. Since this operation includes loss of differential pressure, it can be required to shut down wells that are not producing natural before the pump is started to avoid back flow into the reservoir.

Criteria's:
One pump in operation
By-pass mode: V3 and V4 open, speed below bypass mode set speed.

#	Description	Reference / Value
7.4.1	Read the procedure from top to bottom before any action in started.	
7.4.2	Shut down wells that are not producing natural if required (by-pass mode may cause back flow!)(procedure 7.3) Hess to verify	
7.4.3	Reduce speed of pump until differential pressure over the pump is 3 bar.	
7.4.4	Open bypass valve (V3)	
7.4.5	Open re-circulation valve (V4)	
7.4.6	Reduce speed below bypass mode speed (value found in Operate pop-up window)	
7.4.7	Start pump that is not running, A or B	
7.4.8	Check that both pumps have "identical" differential pressure. If one is producing differential pressure and one is not, stop the pump that is producing differential pressure, wait until the pump running is producing differential pressure and restart the stopped pump.	
7.4.9	Follow procedure 6.1 to restart wells.	
7.4.10	Re-open wells that were shut-down according to procedure 7.2.	

7.5 Stop of one pump when both pumps are running.

One pump can be stopped with one pump running only if the pump is in bypass mode. Since this operation includes loss of differential pressure, it can be required to shut down wells that are not producing natural before the pump is started to avoid back flow into the reservoir.

Criteria's:
Two pumps running
By-pass mode: V3 and V4 open, speed below HOLD rpm.

#	Description	Reference / Value
7.5.1	Read the procedure from top to bottom before any action in started.	
7.5.2	Shut down wells that are not producing natural if required (by-pass mode may cause back flow!). Hess to verify. *If it is only one well that is not producing naturally, route this well through the flow meter, initiate the flow meter with the correct well. Reduce speed of pump until the well is not flowing. Then close well.*	
7.5.3	Reduce speed of pumps until differential pressure over the pumps are 3 bar.	
7.5.4	Open bypass valve (V3)	
7.5.5	Open re-circulation valve (V4)	
7.5.6	Reduce speed below bypass mode speed (value found in Operate pop-up window)	
7.5.7	Stop pump A or B	
7.5.8	To bring the pump running back in normal operation, follow the start up procedure 6.1.	
7.5.9	For a long term shut-down of the stopped pump, set the barrier fluid system in Shut-In mode first level (From Mac panel in PCM)	

8 STOP OF THE PUMPS

The PCS is made such that the operator can press STOP PUMP from any operating point. The system will slowly reduce the pump speed. The power is cut when the pump differential pressure is below 3 bar. When the power is cut, the by-pass valve V3 and re-circulation valve (V4) are automatically opened.

However, it is recommended to stop the pumps manually.

Criteria's:
One or two pumps running

#	Description	Reference / Value
8.1.1	Read the procedure from top to bottom before any action in started.	
8.1.2	Check that topside methanol pumps are running.	
8.1.3	Open topside methanol injection valve to pressurise the methanol line in the umbilical. Note volume displayed at flow counter.	
8.1.4	Shut down wells that are not producing naturally if required. Hess to verify. *If it is only one well that is not producing naturally, route this well through the flow meter, initiate the flow meter with the correct well. Reduce speed of pump until the well is not flowing. Then close well.*	
8.1.5	Reduce speed in steeps until differential pressure is 3 bar	
8.1.6	Open bypass valve	
8.1.7	Stop the pump Let the PCS stop the pump and operate the valves. The pump will ramp down according to predefined curve in PLC. At 1200 rpm the power is shut down and the by-pass (V3) and re-circ (V4) valve will start to open (if not already opened). A trip wing valve signal will be sent to Cameron WCS (if the wells should stay in natural production after the pump stop, the trip wing valve signal must be overridden in the Cameron WCS).	Operate…

#	Description	Reference / Value
8.1.8	After the pump has stopped, open methanol injection valves (V8 and V9) and inject 250 L of methanol. Methanol injection must be started within 10 minutes after pump shut down. For further detail see 0.	
8.1.9	Follow Cameron/Hess procedure to shut down well.	
8.1.10	For a long term shut-down of the pump, set the barrier fluid system in Shut-In mode first level (From Mac panel in PCM)	
8.1.11	For a long term shut-down of the pump, isolate the pump using the ROV operated valves. This is only needed if the well is going to continue production naturally without the pump. If ROV is not available, inject MeOH and close V4 after filling.	

8.2 Methanol injection after stop / shut down

In case of a trip of the pump, it is not possible to follow the normal procedure for methanol injection, as for a planned stop of the pump. Below is shown a contingency procedure. Keep in mind that the recycle line is not insulated.

Criteria's:
Pump has tripped or is going to be stopped

#	Description	Reference / Value
8.2.1	Methanol injection should be started within 10 minutes after the pump has stopped. For a planed pump stop, point 8.2.2 and 8.2.3 in this procedure should be carried out before the pump is stopped.	
8.2.2	Check that topside methanol pumps are running.	
8.2.3	Open topside methanol injection valve to pressurise the methanol line in the umbilical. Note volume displayed at flow counter.	
8.2.4	Open subsea methanol injections valves (V8 &V9) from HMI system.	
8.2.5	Inject 250 litre of methanol to protect re-circulation loop. If pump is to be restarted within HOLD hours, methanol injection can be stopped, otherwise continue methanol injection until the complete module is filled up, total 1300 litres.	
8.2.6	After the module is filled up, closed the V4 to stop any flow through the re-circle line.	
8.2.7	For a long term shut-down of the pump, isolate the pump using the ROV operated valves. This is only needed if the well is going to continue production naturally without the pump.	

9 WELL TESTING WITH MPFM

One of the suction branches to the pump has a multiphase flow meter installed. This flow meter shall be used to do flow measurements of each well. The flow data from the flow meter are also used as input to the total GVF calculation in the PLC.

Criteria's:
Pump in stable operation

#	Description	Reference / Value
9.1.1	Read the procedure from top to bottom before any action in started.	
9.1.2	Check in HMI system which header the well for test shall be routed to.	
9.1.3	Operate manifold valves from Cameron system so that only the well for test is routed through the MPFM. Do not close both manifold valves for a flowing well at the same time, open first both, and then close the original open valve.	
9.1.4	Select the well for test in the HMI system.	
9.1.5	Press the Initiate button. This action will send a new data set from the flow computer located in the PCM down to the flow meter. This operation takes about 5 min! When the start button is highlighted the system is ready.	
9.1.6	Press start. The top row of the well test table will now display continues average well data. Trended online data is shown in the trend window below the table.	
9.1.7	The test continues until the stop button is pushed. To stop test, press stop!	
9.1.8	After a test is carried out, the test must be accepted or rejected. Pushing the accept button will store the new test data into the database and back into the PLC as new flow data for this particular well. If the reject button is pushed, the data is lost!	

9.1.9	The download button allowed the user to store well test data from test separator or earlier test data back into the PLC.	
9.1.10	Well tests at different locations (C1, C5 & CC) can be taken simultaneously.	
9.1.11		
9.1.12		
9.1.13		

10 PRESSURE TESTING OF FLOW LINES / RIGID JUMPERS

For pressure testing of flow lines reference is made to the following procedures:

C1: 4553-1021-D C1 Start up procedure
C5: 4553-1022-D C5 Start up procedure
CC: 4553-1023-D CC Start up procedure

11 PIGGING OF FLOW LINES

For pigging of flow lines reference is made to the following procedures:

C1: 4553-1021-D C1 Start up procedure
C5: 4553-1022-D C5 Start up procedure
CC: 4553-1023-D CC Start up procedure

12 PREPARATION OF FDS TO INSTALL/RETRIVE MPP, MPFM AND RE-CIRC CHOKE

The FDS process system has 3 retrievable components. Before the components are retrieved the following procedure should be carried out.

#	Description	Reference	Value	Sign.
12.1.1	Pumps are shut down according procedure.			
12.1.2	Inject methanol in by-pass line.			
12.1.3	Shut down wells.			
12.1.4	Set barrier fluid system in shut-in mode first level.			
12.1.5	Fill module with liquid not harmful to the environment.			
12.1.6	Performed the following valve operation with ROV: ❑ Closing V1 ❑ Closing V2 ❑ Closing V5 ❑ Closing V6			
12.1.7	Open pipe clamp on selected component.			
12.1.8	Allowed process pressure to equalize with sea pressure.			
12.1.9	Follow the retrieval procedure for the actual component; MPP: 4553-xxxx-D MPFM: 4553- Choke: 4553-			

#	Description	Reference	Value	Sign.
12.1.10	After a new component is installed; use ROV to operate the following valves: C1: ❑ Open V1 ❑ Closed V2 ❑ Open V5 ❑ Open V6 C5/CC: ❑ Open V1 ❑ Open V2 ❑ Open V5 ❑ Closed V6			
12.1.11				
12.1.12				

13 SPECIAL OPERATIONS

#	Description	Reference / Value
13.1.1	Cameron reboot of control system: A reboot of the Cameron system will cause a pump trip and loss of operational control of valves at the tree for a period of about 20 minutes. Therefore the following procedure should be followed prior to rebooting: ❑ Perform a normal stop of the pump (chapter 8) ❑ Stop the well ❑ Fill methanol according to procedures (8 or 8.2) ❑ As soon as the reboot is finished and tree-controls are up and running again, the start-up procedure can be followed.	.
13.1.2	Pod installation/removal The valve pod can be	
13.1.3	Set-up of pump control system with only one pump installed. Actions to be carried out according to Pump System Commissioning procedure, 4553-.	

13.1.4	Checking for hydrat-plug in pump module If there is reason to believe that hydrates have been formed (for instance after a long period without flow and no methanol injected) actions have to be taken prior to start-up. ❑ Pumps are stopped ❑ Wells are closed ❑ V3 and V4 are open ❑ Start injection of methanol ❑ Close By-pass (V3/V7, must be forced) ❑ If pressure builds up over time, there is probably a hydrate-plug in the pump line or the recirculation-line. If so, two alternative methods are available: o Continue injection of methanol o Reducing the process pressure	

14 FAQ – FREQUENTLY ASKED QUESTIONS

14.1 FAQ – Pump operation

Q: **What is the maximum and minimum speed the pump can operate at ?**

A: The pump can operate between 1500 rpm and 5100 rpm(synchronous speed).

Q: **What is the minimum recommended pump speed for continuous operation?**

A: It is not critical, but it is recommended to keep the speed above 2500rpm. If DHPT demands a lower speed, further opening of the recycle valve will hold the target pressure, whilst speed remains constant at 2500rpm.

Q: **What is the effect of increasing the pump speed?**

A: Increasing the pump speed will reduce the pump suction pressure, and consequently the wellhead- and downhole pressure. Decreasing the speed will likewise increase the pump upstream pressures.

Q: **What is the effect of reducing the V4 choke opening?**

A: Choking the recycle line will reduce the pump suction pressure and consequently the wellhead- and downhole pressure. And vice versa.

Q: **The downhole pressure is unstable. Why?**

A: The downhole pressure can be unstable for several reasons. There could be slugging in the well, at wellhead or in the flowline. It could also be changing of speed and/or choke settings too fast (unstable regulation). The best advice is to wait, and to adjust only speed or only choke at a time. In some cases it may be wise to increase opening of V4 to stabilise the pump conditions. Things may also become more stable as temperature increases in the flowline.

Q: **What is the maximum pump differential pressure ?**

A: Maximum is 40 bar, the pump trips at 42 bar. Remember that the drawdown limitations in the well can occur with a lower pump differential pressure than 40 bar!

Q: **What is the minimum pump suction pressure ?**

A: It is currently set to 10 bara because of the barrier oil pressure and the water-depth

Q: **Do I always have to inject methanol in to the pump module when the pump stops/trips ?**

A: YES ! At least into the recycle line.

Q: **What do I do after an ESD1 ?**

A: MeOH should be injected ASAP to both all Pump modules (ref. 8.2)

Q: **After a start-up, why does the pump differential pressure have to be reduced in order to keep the downhole pressure constant?**

A: It can be several reasons: The heavy liquids (i.e. water and oil) that was in the flowline prior to start-up, have been pumped out; the watercut has changed; the well has stabilised; temperatures or flow regimes have changed etc.

Q: **Why is the pump increasing or decreasing the speed at a slow rate ?**

A: First of all, the response time from the well and flowline is long, and the fluids in the system are compressible. In addition, the barrier oil pressure needs time to adjust, and the umbilical makes the response slower due to its accumulator effect.

Q: **How is the bypass-valve V3/V7 operated?**

A: The bypass-valve is operated by pointing on the valve and clicking once with the mouse. A pop-up window will appear where you can give Open or Close command. Valve position is also shown.

Q: **Why does the pop-up window for the bypass-valve V3 say 'V3 NOT CLOSED' instead of 'V3 OPEN' ?**

A: The bypass-valve is a Fail-Safe-Open valve. The higher actuator pressure therefore indicates when the valve is pushed towards closed position.

Q: **Are there any limitations to the operation of the valves when it comes to functionality?**

A: V4 is defined as 'open' when it is above 48%, start permissive one pump and 95%, start permissive two pumps. V4 is given a SP of 50% if a pump stop/trip occurs. Also V3 will open then. It is not possible to close V3 while the pump is not running.

Q: **Why does the procedure say V4 >=10%?**

A: This is simply because of the S-shaped Cv-curve for the valve. Choking lower than 10% has no effect on the flowrate (constant Cv below 10%). However, it is more than sufficient to prevent hydrate formation in the recirculation line even when operating at low differential pressure. By limiting it to 10% you also don't waist time when you want to have open it again.

Q: **What do I do if I get lost and are facing the risk of drawing down the well without control?**

A: If there is not enough time to let the speed or choke decrease the pump differential quick enough, there is and Emergency Stop button on the process screens. You will be asked for confirmation. This will trip the pump immediately.

14.2 FAQ – Barrier oil system

Q: **What is the barrier oil system ?**

A: The barrier oil has the following main purposes:

- Overpressure protection of the pump internals
- Lubrication of bearings and seals
- Cooling of the submerged electrical motor

Q: **Why does the barrier oil pressure have to be higher than the process pressure ?**

A: Because this prevents process fluids to enter the electrical motors, seal surfaces and bearings.

Q: **Is the barrier oil system operated from the control room (OS) ?**

A: No, the barrier oil is system is automatically regulating the pressures by looking at the process disharge pressure. The operator can monitor the system from the OS.

Q: **Do I ever turn the barrier oil system ON/OFF ?**

A: The system should never be turned off. It is not possible to turn off the system from the OS anyway. In case of power loss the system will restart automatically when power is back again.

Q: **What is 'Shut-in mode' ?**

A: 125bara is the maximum process pressure the pump could operate at in running mode. The pump will trip if the pressure gets higher. However it is recommended to have the same overpressure as in running mode. The system will therefore automatically increase the pressure in three steps if required. If the process pressure drops again, the system will also decrease the pressure automatically to normal mode where the pump can be started.

Q: **Why are there 2 tanks for the barrier oil ?**

A: Oil is filled on the circulation tank. A hydraulic pump will force the oil through a water- and a particle filter. When the oil has the required cleanliness it can be transferred to the system tank by opening the manual 3-way valve. Samples have to be taken prior to the transfer. The oil that is in the system tank will be supplied to the subsea pump.

Q: When do I pump oil from the recirculation tank to the system tank?

A: There is an alarm when the oil level in the system tank is below 50%. This is a reminder to fill oil If oil samples from the circulation tanks have the required cleanliness, it can be transferred to the system tank by opening the manual 3-way valve. Samples have to be taken prior to the transfer.

Q: Where can I see the tank levels?

A: The tank levels can be seen in the picture 'Barrier oil system' on the OS. There are also indicators on the tanks located in the PCM.

Q: Why is the level in the system tank dropping?

A: There should be a small consumption of barrier oil (however it is estimated to be less than 1 liter/hour, typically 0.2-0.4l/h per pump). If the oil consumption is significantly larger, Framo should be notified (see chapter 1.3).

Q: What kind of oil is used as barrier oil ?

A: The oil is a Shell Morlina VG5. **No** other oil can be used.

Q: Are there any requirements to the barrier oil ?

A: Yes, cleanliness min. NAS class 6 and a maximum water content of 100 ppm.

Q: What is the purpose of local/remote switches for the HPU pumps on the control panel front?

A: By switching a pump to local, the pump can be started and stopped from the control panel front. Even if the pump is in manual, it will stop if maximum pressure is reached.
During transfer of oil from the circulation tank to the system tank, the circulation pump has to be switched to local, and manually operated from the panel front. The pump will stop when system tank level has reached 95%, but the operator still has to closely watch the system tank level.

Q: What happens if the two main- and back up pumps are switched to Local?

A: Switching both pumps to local at the same time, means that the pumps no longer are operating with respect to the system pressure. That means that the HPU is not in operation, and a "HPU Tripped" alarm will be initiated.

Q: Will an "HPU Tripped" indication trip the subsea pumps?

A: No, the subsea pumps are tripped based on the subsea barrier oil pressures. An HPU trip will not affect these pressures immediately, but as pumps consume oil, the subsea pressure will fall, and consequently, if the HPU is not feeding oil to subsea, the pump will eventually trip.

14.3 FAQ –Valve Control System

Q: **What is the control fluid system?**

A: Control fluid is supplied to the retrievable solenoid pod, that in turn controls the hydraulic operated bypass- and recycle valves.

Q: **Do I ever turn the control fluid system ON/OFF?**

A: The system should never be turned off. It is not possible to turn off the system from the OS anyway. In case of power loss the system will restart automatically when power is back again.

Q: **Is the control valve system operated from the screen (OS)?**

A: No. The operator can monitor the control fluid HPU system from the OS.

Q: **Are there any requirements for the oil to the lip seal and control valve system?**

A: Yes, the cleanliness of the oil shall be better than NAS class 6.

Q: **Where can I see the tank level?**

A: The tank level can be seen in the picture 'Control fluid system.' on the OS. There are also indicators on the tanks located in the PCM.

Q: **Why is the tank level dropping ?**

A: When the valves are operated, the return oil from the actuators is vented to sea, and the system has to be re-filled from the topside tank.

Q: **How often do we need to refill oil to the control fluid system?**

A: This is depending on the number of valve operations, but a good practice is to re-fill when low level alarm occurs at 50% level.

Q: **What happens if the control fluid pressure drops?**

A: If the control fluid pressure drops dramatically it could indicate that the process is leaking to sea. The Control fluid HPU will trip (outlet solenoid activated). To get the HPU back in operation, the solenoid has to be forced open to increase the supply pressure above low-low level.

Q: **Are there any limitations to the operation of the valves ?**

A: In case many valve operations are performed in very short time, the supply pressure topside may have dropped, and the HPU will need to boost the pressure in the supply line. A few seconds delay may be observed. In worst case this can trip the HPU. To get the HPU back in operation, the outlet solenoid has to be forced open to increase the supply pressure above low-low level.

14.4 FAQ – VSD and Trafo

Reference is made to ABB documentation xxxxx.

Q: **VSD ready signal is missing, how do I get it back?**

A: In the VSD control panel front there is a Main Contactor switch. Close the main contactor by turning the switch first counter clockwise, then clockwise.

A: A hi-hi temperature in the transformers will trip the main contactor. Check alarm/event list on OS.

A: Loss of 6.6kV feeder to the PCM will cause the VSD to trip. The main contactor must be switched back on when the HV power is back.

A: A pump trip might cause an inhibit of VSD ready signal, press the reset button on HMI or VSD reset button on control panel front.

Q: **How do I reset a VSD trip?**

A: Close the main contactor with the switch on VSD panel, the press VSD reset button on Pump Control System panel in PCM.

Q: **VSD give no speed after start is initiated.**

A: First attempt is to try for a new start. If the Frequency converter is not getting the speed reference signal, reset the profibus communication by switching off and on power to the ABB AC80 control unit.

Q: **Step up transformer is overheating.**

A: If the S.U. trafo gets a High temp alarm, the pump speed should be reduced to decrease the trafo load, thus lowering the temperature.

If a HH alarm occurs, the VSD system will trip, and the pump will have a fast ramp down stop (fast ramp down is full speed to stop in 10 seconds).

Q: **Step down transformer is overheating.**

A: If the S.D. trafo gets a High temp alarm, at least on of the pump's speed should be reduced to decrease the trafo load, thus lowering the temperature.

If a HH alarm occurs, the VSD system will trip, and the pumps will have a fast ramp down stop (fast ramp down is full speed to stop in 10 seconds).

Q: **Will a Water Cooling Unit failure cause the pumps to trip?**

A: Yes, any failure in the two individual circuits in the WCU, will cause the adjacent frequency converter to trip.

Q: **The VSD room temperature is rising due to HVAC failure, will this cause the pumps to trip?**

A: Eventually, yes. At 40 degrees C, a VSD room temp high alarm will occur, and at 42 deg.C trip the VDS's.

14.5 FAQ – HMI in PCR

Reference is made to HMI User manual, document 4553-xxxx-D.

Q: **What happens if the PC is shut-down because of a power failure?**

A: The PC restarts by itself. Login as 'Operator'. There is no password.

Q: **If the HMI screen freezes, what do I do?**

A: An alarm for Ethernet/PLC communication fault will indicate on top of the screen picture. There are several ways of getting the communication back, the easiest is to reboot the HMI computer by switching it off and on.

Q: **I press 'Update', but 'ACTUAL S.P.' is not updated?**

A: The communication from HMI to PLC is probably down. A restart of the PC in the PCR is required.

Q: **In the trend-pictures I cannot see all tags in the graph?**

A: The scale has to be reset to fit all 4 lines. The maximum and minimum value of the Y-axes can be set by clicking on the max and min value.

Q: **When I try to zoom in the data the pictures jumps back to original. What should I do?**

A: You have to switch from 'Live trending' to 'Lock' by Clicking the switch in the lower right corner.

Q: **I want to look at data that are older then the data in the current picture. What should I do?**

A: The historical trend window allowed you to look at older data.

Q: **Can I see trends of other tags?**

A: Using the Custom trend window you can trend any Tag nr. Maximum 10 Tag's in the Trend window.

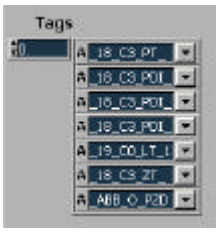
Q: ***I am requested to save data to a file and e-mail them to someone. How?***

A: *You need to do as follows:*

- *Find out which tags you should retrieve from the data base*
- *Go the 'Print/Save/Exit' menu, F[12]*
- *Click off the 'Interpolate data'*

- *Select the time-frame you want data from:*

- *Select the tags you want to write to a file. If you have more than 6 tags you can get more by clicking here:*



- *Press the 'Write'-button*
- *Select file location and save the file*
- *The file can now be send to a floppy disc and e-mailed*
- *NOTE: If the file becomes too big for a floppy-disc, change the stop time and generate two or more files instead.*

14.6 FAQ – PCM utilities

Q: Why is it necessary to keep the outer door closed in the PCM?

A: The PCM is designed for zone 2 environment, and therefore has a sensor monitoring the overpressure inside, giving an alarm if the differential pressure between inside and outside is below 0.2 mBar (20mmwg). Leaving the door open, will also allow humid air to enter the PCM. The air conditioning units are not only controlling the indoor temperature, but also air humidity. Moisture is knocked out of the air by cooling down below the dew point, and if the cooling demand is low (i.e. VSD not running), the cooled air is re-heated to sustain correct room temperature.

Q: If both HVAC units trip, would also the pumps trip?

A: No, only if the temperature in the module exceeds 42 degC

Q: How is overpressure maintained in the module?

A: By an overpressure fan located close to access entrance.

Q: When will the fire dampers close?

A: If the PCM looses power supply and UPS, fire dampers will close.

Q: What is regulating the water supply to the PCM?

A: An automatic valve.

Q: Does the trapped water underneath the HPU room floor need to be drained?

A: No, water in the tray is drained through a water trap to the outside of PCM.

Q: Where is return water from PCM going?

A: Directly overboard, no valves.

Q: Why is water collected underneath the floor in PCM HPU room?

A: Because the HVAC units knock out water from the air, and the tray underneath has a water trap to prevent module overpressure to blow out the water, causing overpressure to drop.

Q: Where can I find fault messages inside the PCM?

A: All alarms will be displayed on the MAC panel on the control panel front.

(If alarms have not been acknowledged for a long time, they might drop out of the MAC panel alarm list. By disconnecting and reconnecting the power supply socket on the backside of the MAC panel, the alarms will be restored. This can be done without tripping the pumps).

Q: Will a smoke detection inside PCM trip the pumps?

A: No, smoke detection only gives an alarm in the fire and gas system.

Q: Will manual call point activation inside the PCM stop the pumps?

A: Yes, 440V and 6.6kV to PCM will be tripped.

Q: Can the fire dampers be tested without tripping the subsea pumps?

A: Yes, a test button inside the HPU room will close the dampers, with no indication to the F&G system. The fire dampers have to be manually reset.

Q: Can the emergency stop push button on barrier HPU and Control fluid HPU be activated without tripping the subsea pumps?

A: The respective ESD button will trip the HPU pumps only, the subsea pumps will continue as long as the pressures are OK

Q: Can one HVAC unit be stopped without tripping subsea pumps?

A: Yes.

Q: Is it possible to fill oil when pumps are running?

A: Yes

Q: How do I reset alarms?

A: By pushing the Reset buttons on PCS cabinet.

Q: How do I stop barrier pumps or control fluid pumps if I discover a big leak?

A: By pushing emergency stop buttons in HPU room. This will not trip the subsea pumps.

Q: Is it possible to isolate pipes to subsea in case of maintenance/repair?

A: Yes, look at the P&ID for this subject.

Q: On differential pressure alarm on filters, is there any indication on which filter is clogged?

A: Yes, a red pop up flag on the respective filter will indicate clogging.

Q: Is it possible to isolate cooling water to HVAC or VSD?

A: Yes, look at the P&ID for this subject.

Q: Is there a light switch for outside/inside lights?

A: No, fuses are located inside the fuse cabinet.

Q: How do I stop room overpressure fan?

A: By switching of the fuse inside fuse cabinet. This is not a normal operation.

Q: How is overpressure inside PCM adjusted?

A: By a sliding damper downstream the ventilation fan.

14.7 FAQ - PLC and PCS

Reference is made to User manual, document 4553-xxxx-D.

Q: How is the PLC restarted after a power shut down?

A: The PLC will automatically restart, and all control functions will be back to normal.

Q: Can the subsea pumps be started and operated from the PLC MAC panel?

A: Yes, all functions for pump operation is available on the MAC panel.

Q: Does the subsea pumps trip if they are switched from "Remote" to "Local" on the PCS panel?

A: No, but when operating in "Local", only commands from the MAC panel will be accepted. Commands from the operator screen in PCR will not be executed.

Q: What is a Common Alarm??

A: A common alarm is generated every time an alarm is generated. Each sub system has a Common Alarm every time there is an alarm in the system, ex. VSD Common Alarm, HPU Common Alarm etc. The main purpose of common alarms, is if the OS in PCR is out of operation, each subsystem has a Common Alarm lamp on the PCS panel front. The alarm list in the MAC panel will annunciate each alarm.

Q: Can people other than Framo representatives do logic changes on the PLC?

A: No, a special programming tool with the PLC software is needed, and logic changes shall not be done by others than Framo.

Q: Can the PLC be reset when the subsea pumps are running?

A: No, a PLC reset will switch of the system, and everything will stop.

Q: How do I find the alarm and trip set points?

A: By entering Main Menu on the MAC panel, enter the subsystem (ex. HPU), enter Parameter Settings, and scroll down to the desired tag no.

Q: Is it possible to change set points when the system is in operation?

A: Yes, but a password is required to do any changes. Parameter set point changes shall not be done without consulting Framo.

15 MAINTENANCE

15.1 Barrier oil system

NOTE: There are TWO different units in the HPU Room, and it's very important to distinguish these two units.

The tank for the barrier oil is located next to the exit door. There are two tanks in this system: One circulation tank and one system tank. The barrel pump is connected to the circulation tank through a filter (at the top of the tank) and a small button will appear when the filter is clogged.

The oil has to circulate for a while before you can transfer it into the system tank.

Do always take an oil sample, and make sure that the oil has the correct criteria before transferring:

NAS class 6 or better and maximum 100 PPM of water.

The three way valve has to be switched from "Circulation" to "Filling" position, for transfer of oil from the circulation tank to the system tank.

Both Barrel pumps are labelled (one for Oceanic and one for Morlina VG5). Do NEVER mix the barrel pumps/hoses

IF THE BARREL PUMP FOR ANY REASON DOES NOT WORK, <u>NEVER</u> USE A BARREL PUMP THAT HAS BEEN IN USED WITH OTHER/ UNKNOWN FLUIDS OR CHEMICALS.

Procedure for filling Shell Morlina VG5:

1. Take the barrel pump labelled Shell Morlina VG5 out from the housing, and coil out the hose.
2. Insert the barrel pump into a NEW barrel. (Shell Morlina VG5)
3. Connect an air hose into the barrel pump, and the pump will start.
4. Keep an eye on the level gauge on the tank during filling.
5. Do not fill more than 95% on the level gauge.
6. Disconnect the air hose when the barrel is empty, or the level on the tank is 95%.
7. Coil up the tubing and insert the barrel pump back in the housing
8. Turn the switch in local (19-CX-HS1104A) and start the circulation pump (19-CX- HS1104 B), and let in run in 24 hour.

Procedure for sampling the Shell Morlina VG5:

<u>Circulation tank</u>

1. Open the sample point labelled circulation tank
2. Open the tap and drain the first litre. Do not touch the tap, during sample.

3. You need minimum one litre Morlina to be able to run the PCM (particle counter measurement)
4. Samples have to be taken after circ. pump have been run for 24 hour and before transferring oil into the system tank, else every 3'rd month.
5. Oil is transferred to the system tank by manually switching the 3-way valve (from 'Circulation' to 'Transfer'). Remember to switch back afterwards.

System tank

1. Sample point labelled system tank.
2. Open the tap and drain the first litre. Do not touch the tap, during sample.
3. You need minimum one litre morlina to be able to run the PCM (particle counter measurement)
4. Take a sample after transferring from circ. tank, else every 3'rd month.

Reference is made to document:

4553-1027-D FRAMO FFD Pump System – Topside Equipment Maintenance Manual, section 3.8.8

15.2 Control valve system

NOTE: There are TWO different units in the HPU Room in the PCM, and it's very important to distinguish these two units.

This tank for the lip seal and valve control oil is located at the further end. The colour on the Oceanic 525 is blue/green and it is a water-based oil. The barrel pump is connected into a filter (at the top of the tank) and a small button will appear when the filter is clogged.

Procedure for filling Oceanic 525

1. Take the barrel pump labelled Oceanic 525 out from the housing, and coil out the hose.
2. Insert the barrel pump into a NEW barrel. (Oceanic 525)
3. Connect an air hose into the barrel pump, and the pump will start.
4. Keep an eye on the level gauge on the tank during filling.
5. Do not fill more than 95% on the level gauge.
6. Disconnect the air hose when the barrel is empty, or the level on the tank is 95%.
7. Coil up the tubing and insert the barrel pump back in the housing
8. Turn the switch in local (19-CX- HS1153 A) and start the circulation pump (19-CX- HS1153 B), and let in run in 24 hour.

Procedure for sampling the Oceanic 525:

1. Sample point is labelled oceanic tank. Always take a sample after the circ pump has been run for 24 hour, else every 3'rd month.
2. Open the tap and drain the first litre. Do not touch the tap, during sample.
3. You need minimum one litre Oceanic to be able to run the PCM (particle counter measurement)

Reference is made to document:

4553-1027-D FRAMO FFD Pump System – Topside Equipment Maintenance Manual, section 3.8.9

15.3 VSD

The PCM VSD system comprises one common step down transformer for the two frequency converters, one common AC80 control cabinet, and two step up transformers. For troubleshooting and maintenance reference is made to the following ABB documents:

3AJG000305-840	VSD Frequency Converter, Firmware Manual
3AJG000305-841	VSD Frequency Converter, Hardware Manual
3AJG000305-842	VSD Frequency Converter, Diode Supply Unit, User's Manual
3AJG000305-843	VSD Water Cooling Section, User's Manual
3AJG000305-844	VSD Bender Earth Fault Monitoring Unit, User's Manual
3AJG000305-845	VSD Control Section, AC80 User's Manual
3AJG000305-846	VSD Frequency Converter, Step-Up / Sine filter for ACS600, User's Guide
3AJG000305-847	VSD Topside Transformers, User's Manual
3AJG000305-848	VSD Megacon, User's Manual

Reference is also made to document:

4553-1027-D FRAMO FFD Pump System – Topside Equipment Maintenance Manual, section 3.8.1 – 3.

15.4 Power and Control Module

Reference is made to document:

4553-1027-D FRAMO FFD Pump System – Topside Equipment Maintenance Manual, section 3.8.1 – 3.

16 APPENDIX A - HMI PICTURES

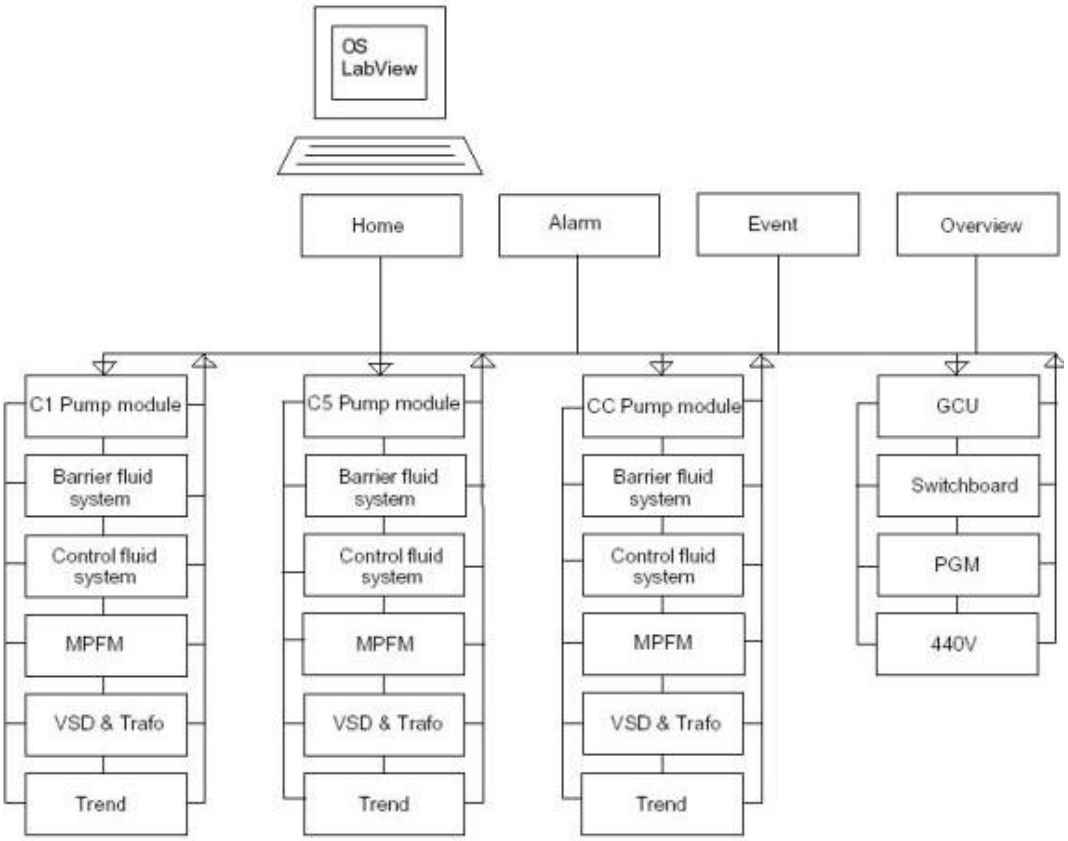


Figure 16-1. HMI hierarchy

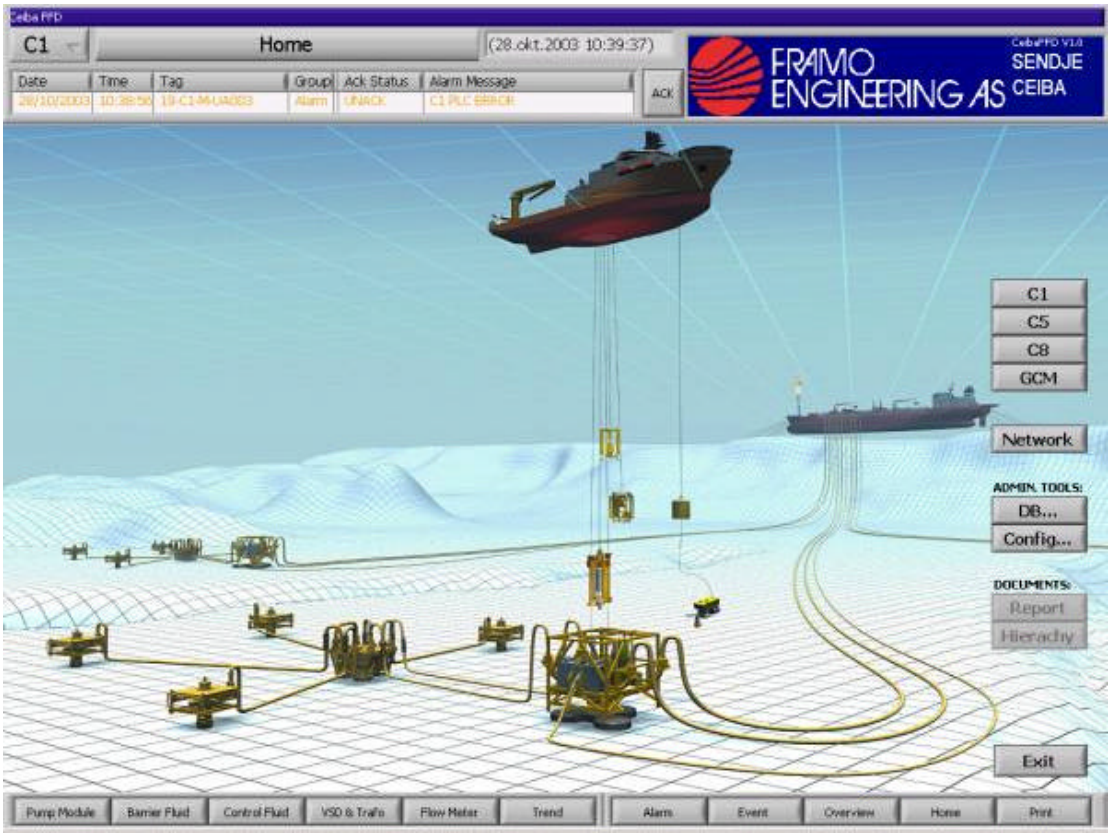


Figure 16-2. Home screen

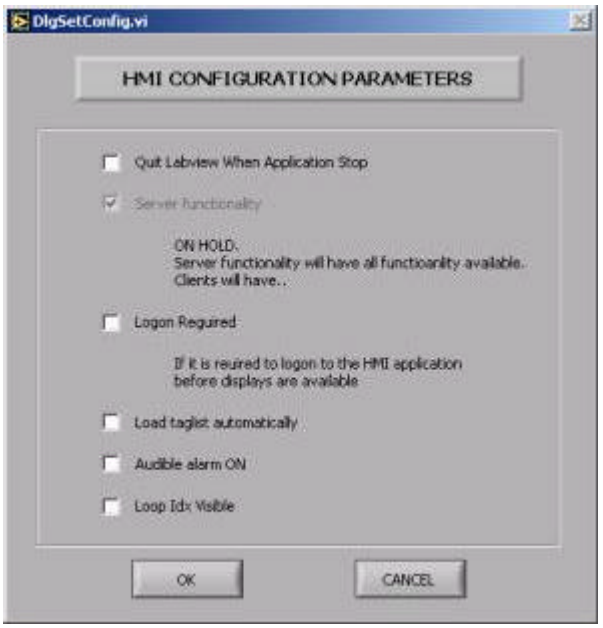


Figure 16-3. HMI configurations parameters.

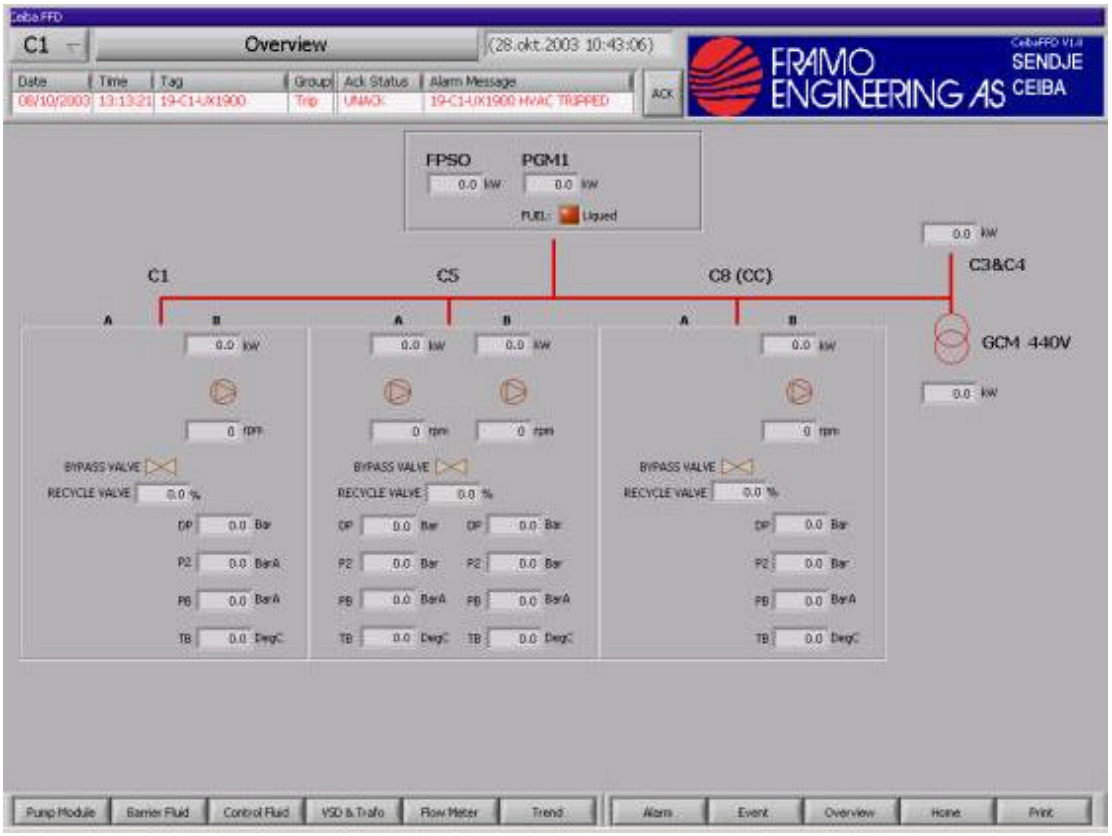


Figure 16-4.Overview.

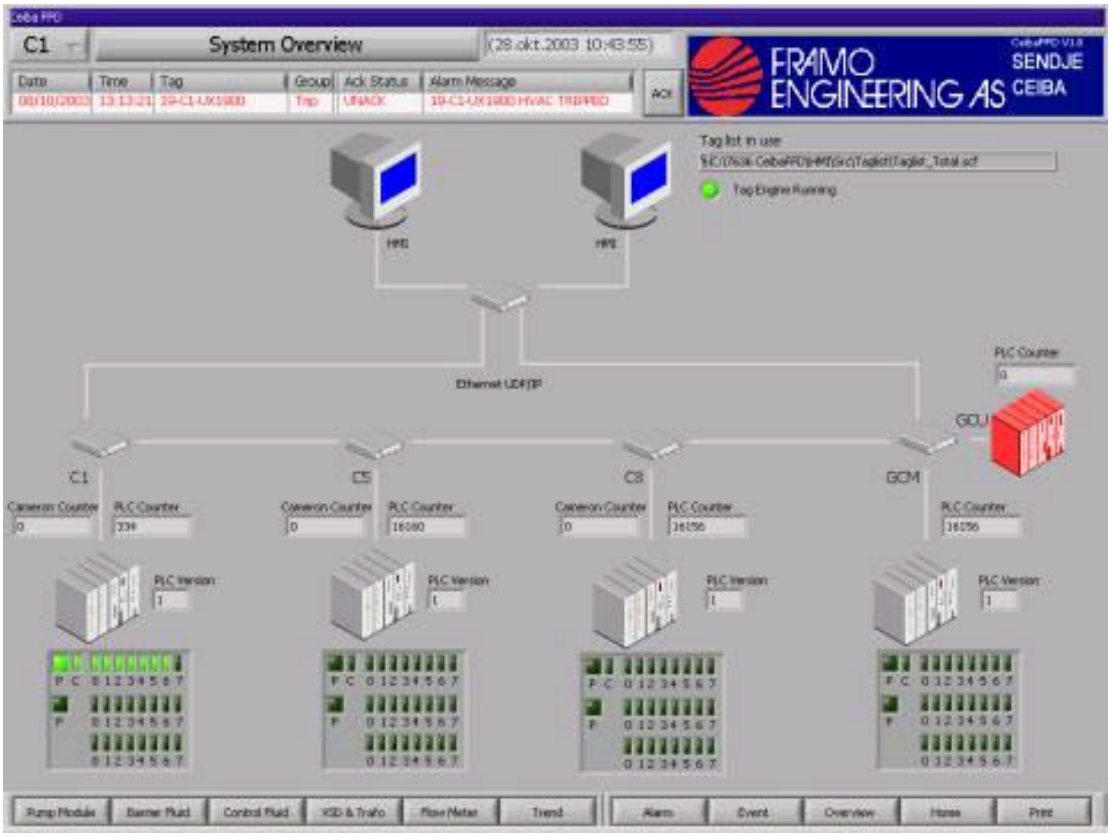


Figure 16-5 System overview

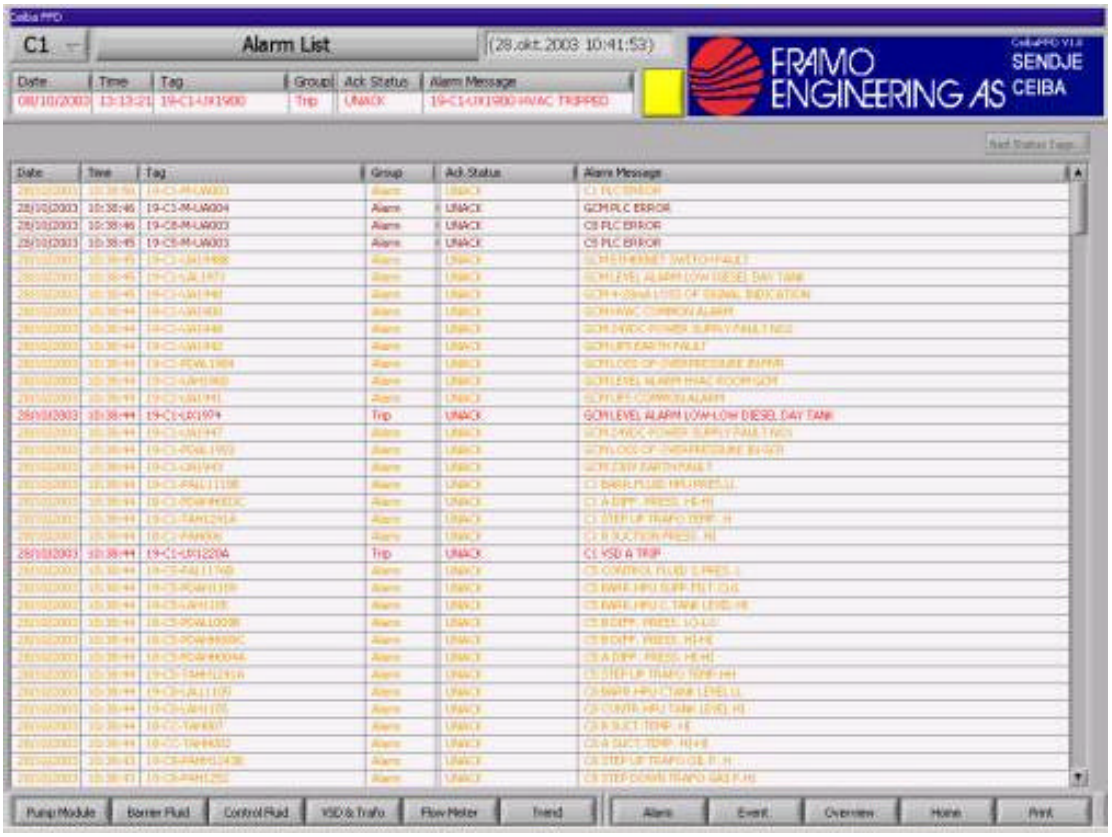


Figure 16-6. Alarm list

Figure 16-7. Event list

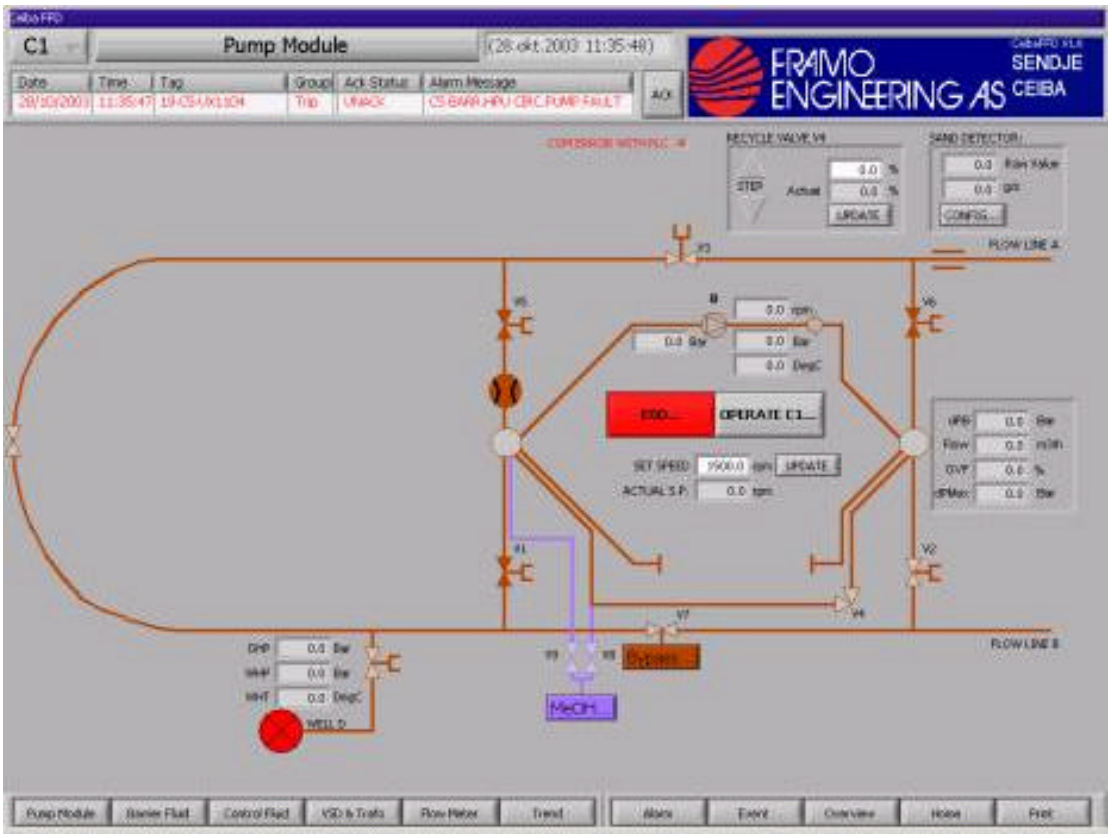


Figure 16-8. Pump module C1

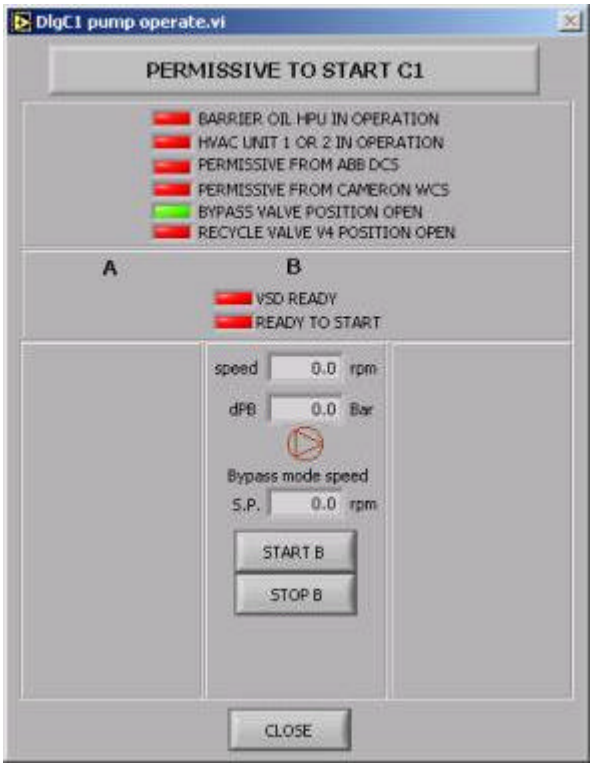


Figure 16-9 Operate Pop-up menu, pump module C1.

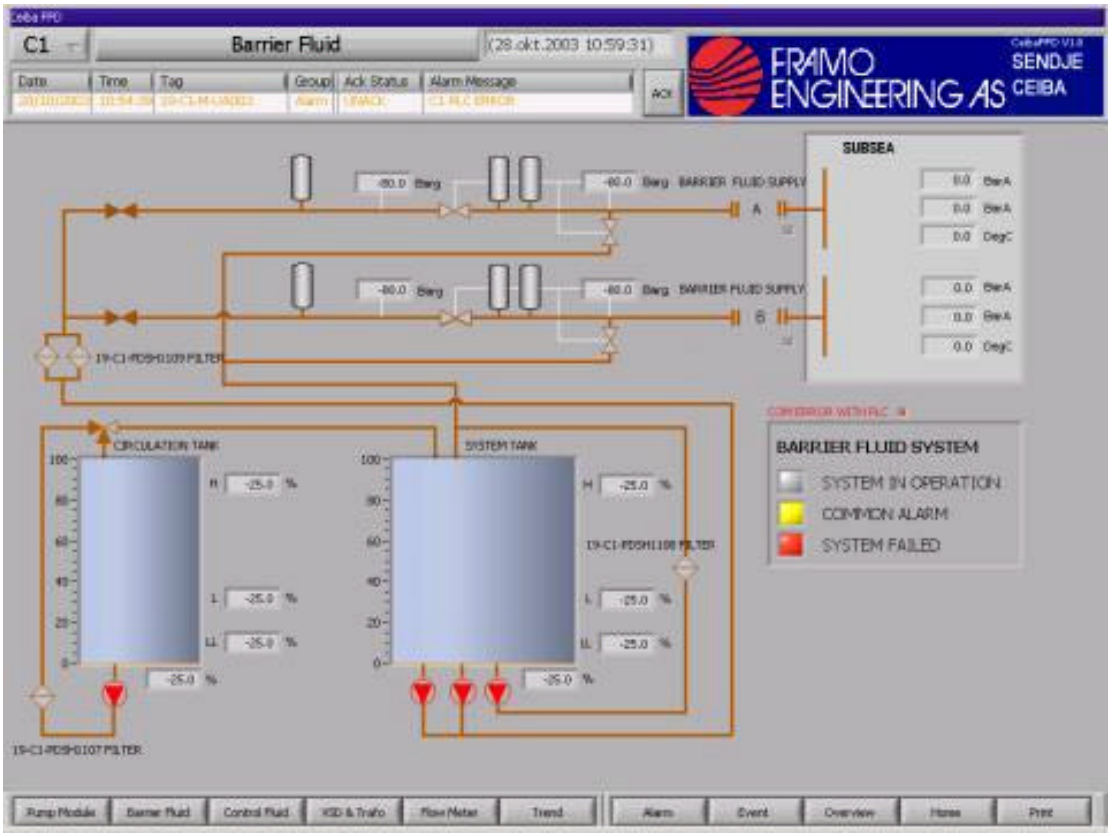


Figure 16-10. Barrier fluid system C1.

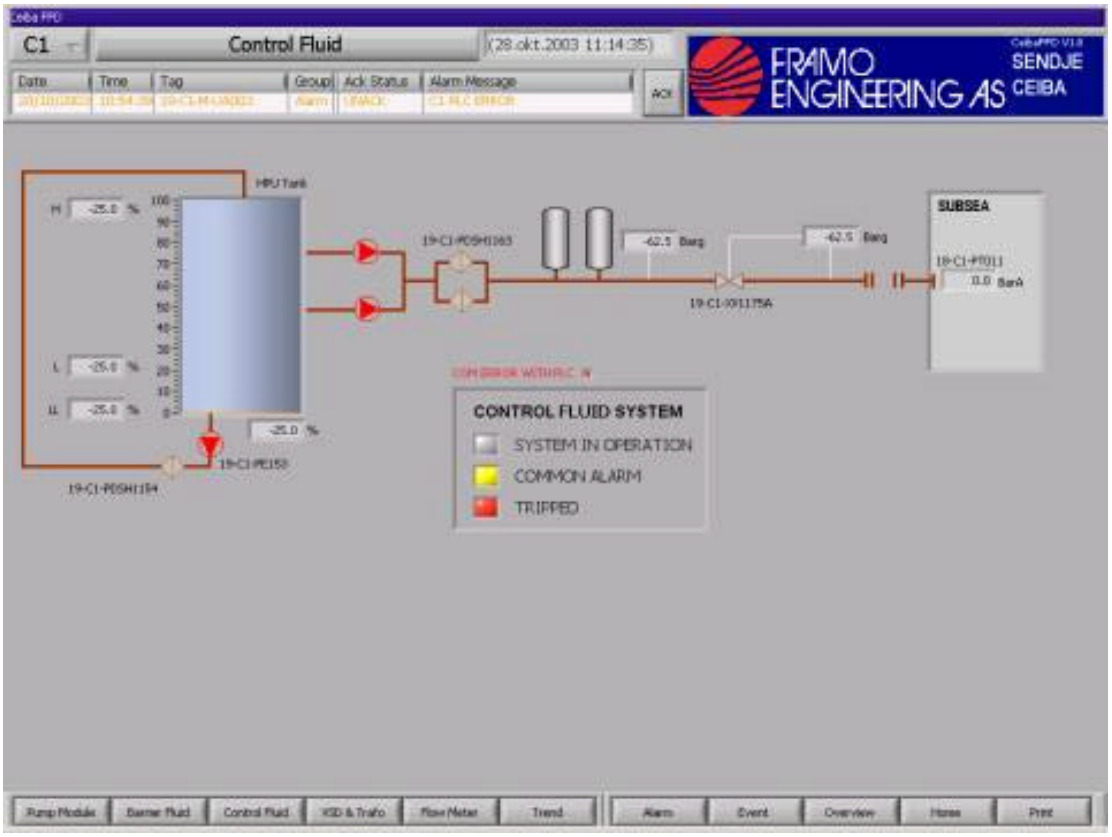


Figure 16-11. Control fluid system C1.

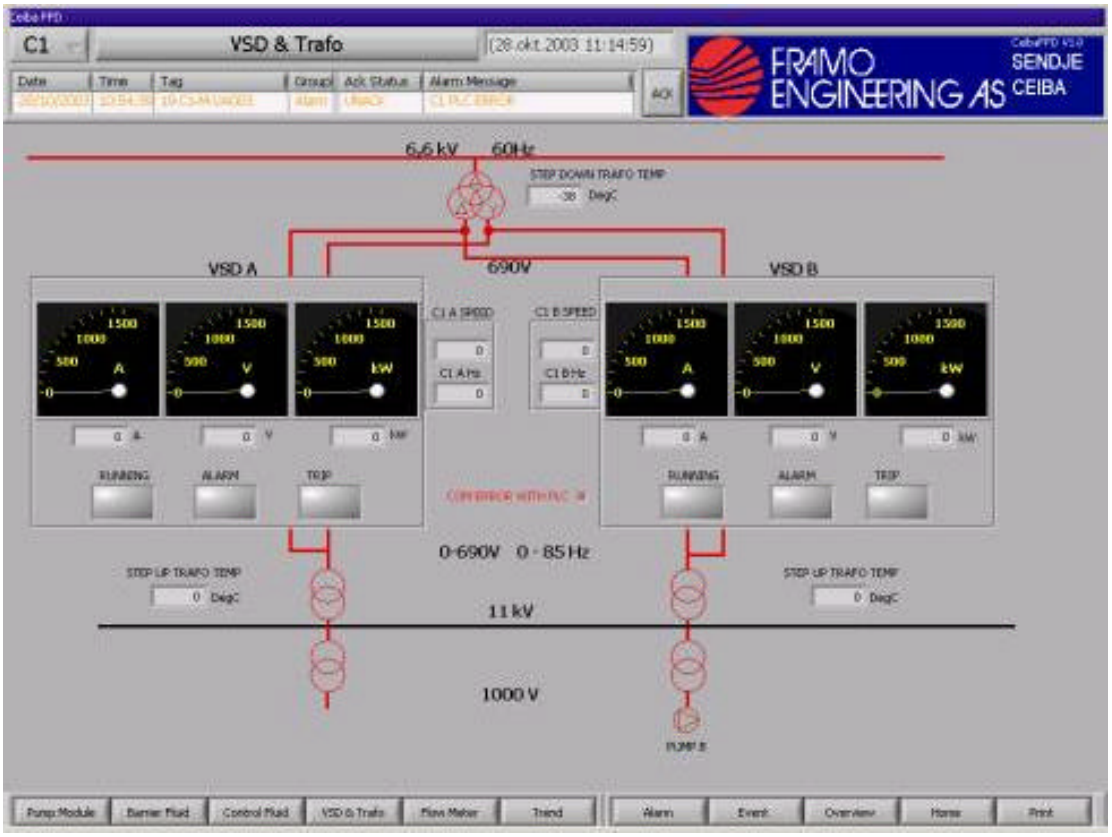


Figure 16-12 VSD & Trafo C1.

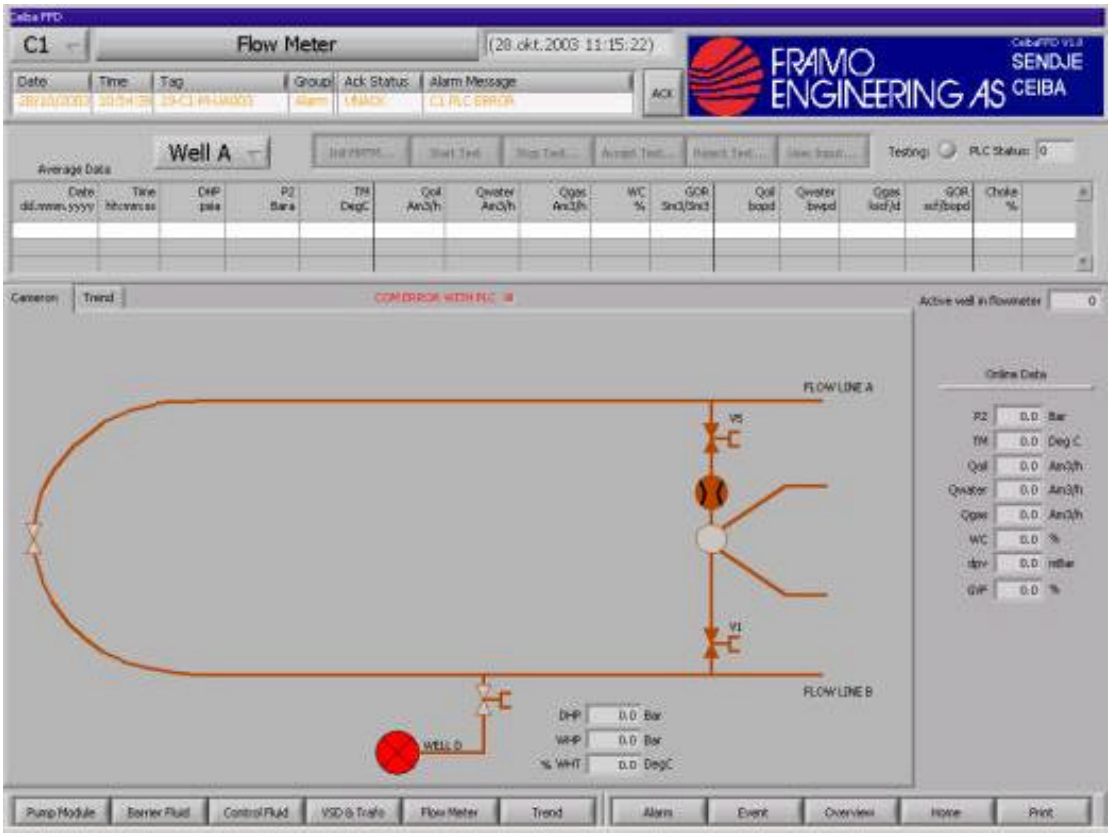


Figure 16-13 MPFM C1, Manifold layout.

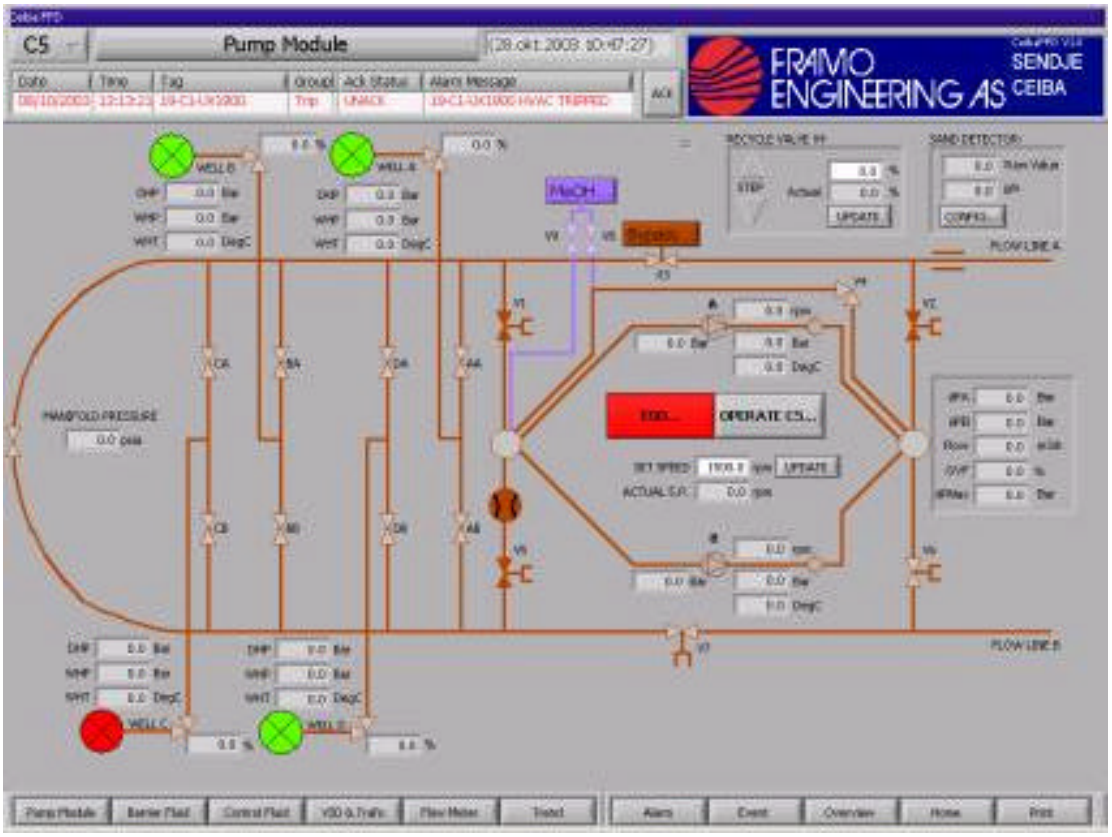


Figure 16-14. Pump module C5

Figure 16-15 Operate Pop-up menu, pump module C5.

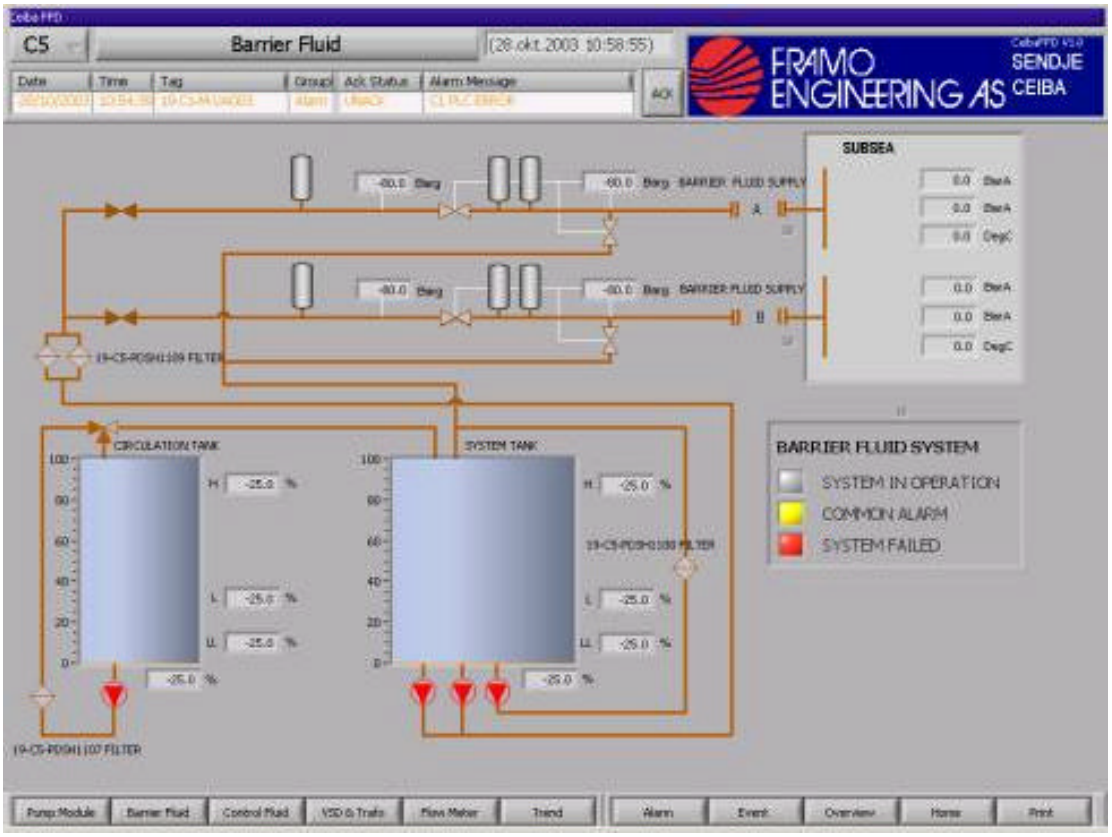


Figure 16-16. Barrier fluid system C5.

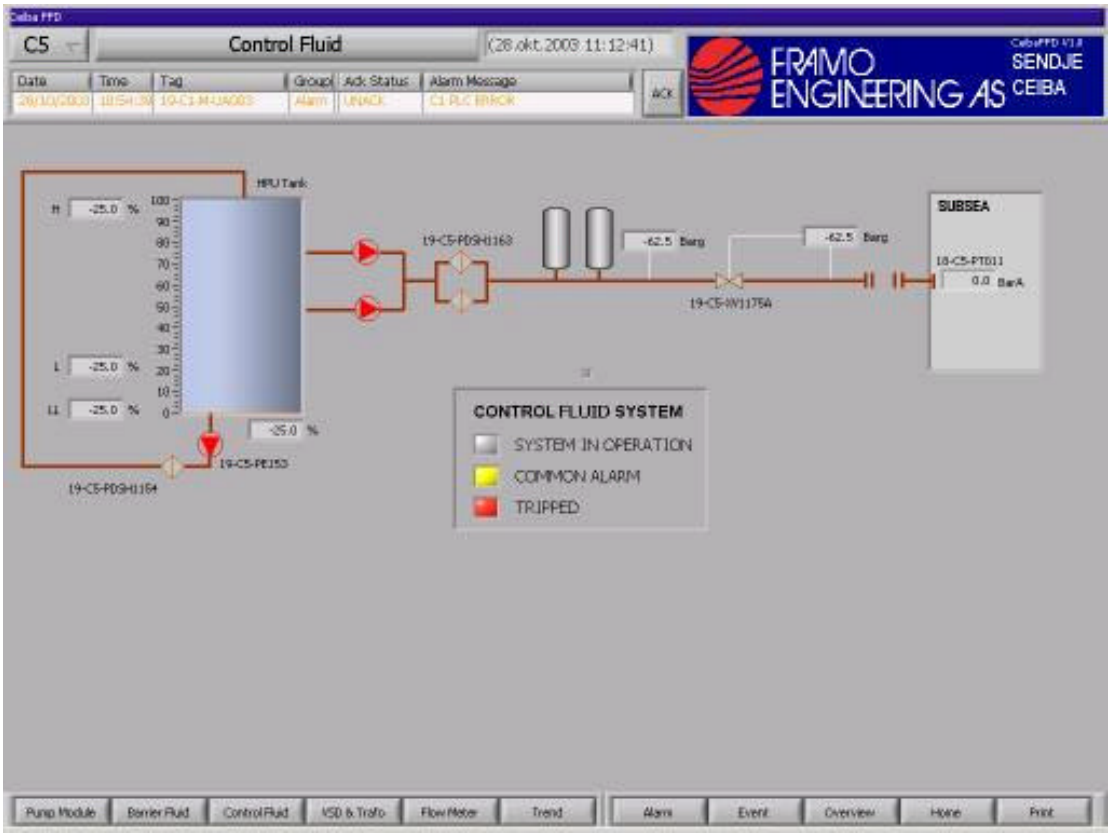


Figure 16-17. Control fluid system C5.

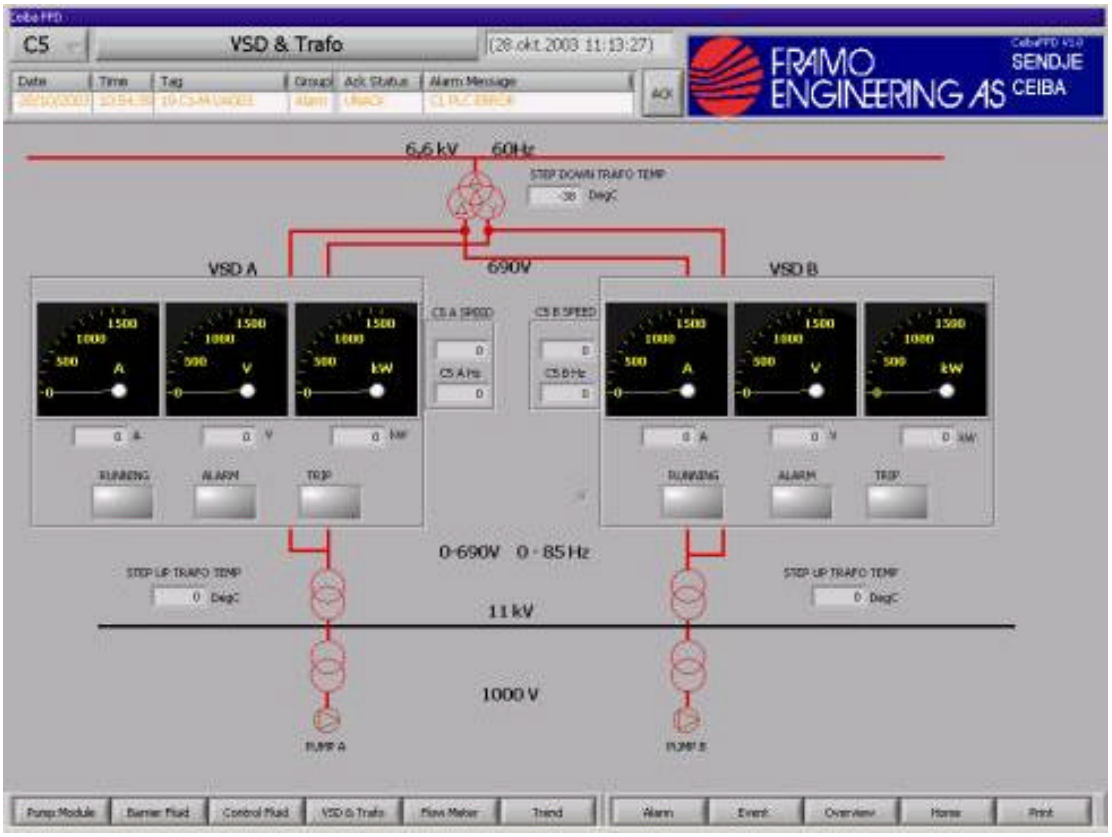


Figure 16-18. VSD & Trafo C5.

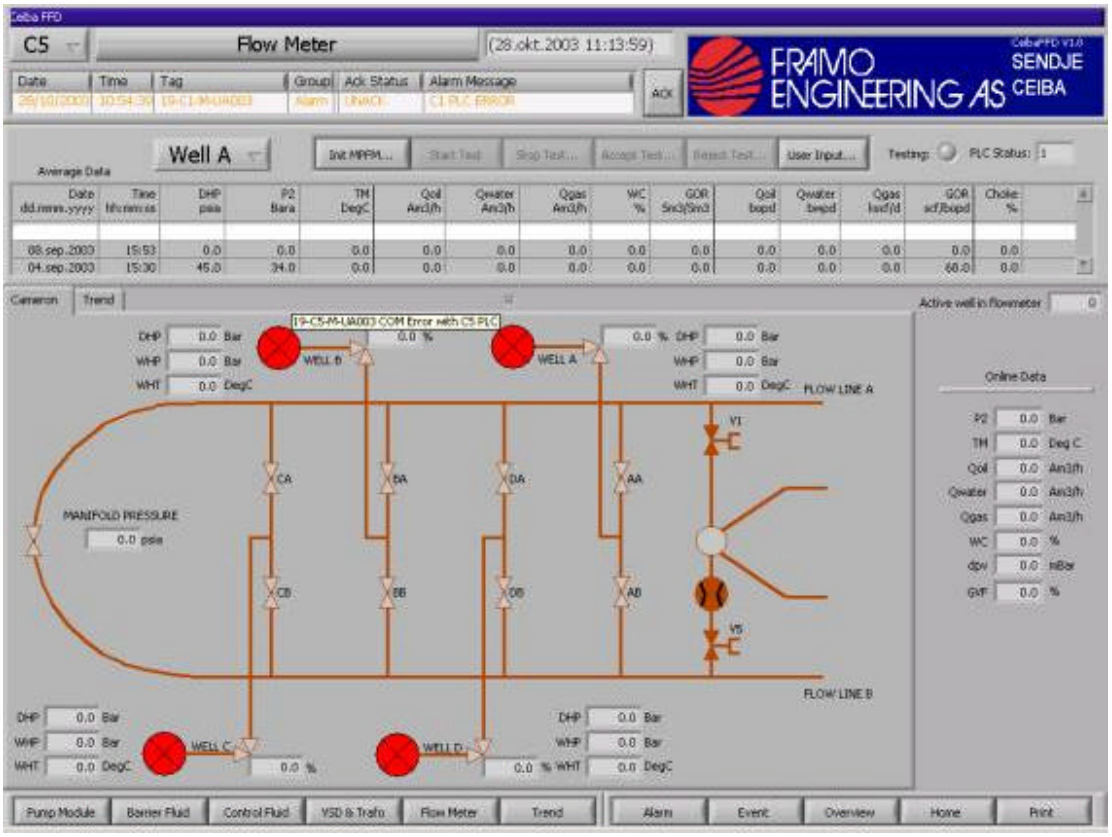


Figure 16-19. MPFM C5, Manifold layout.

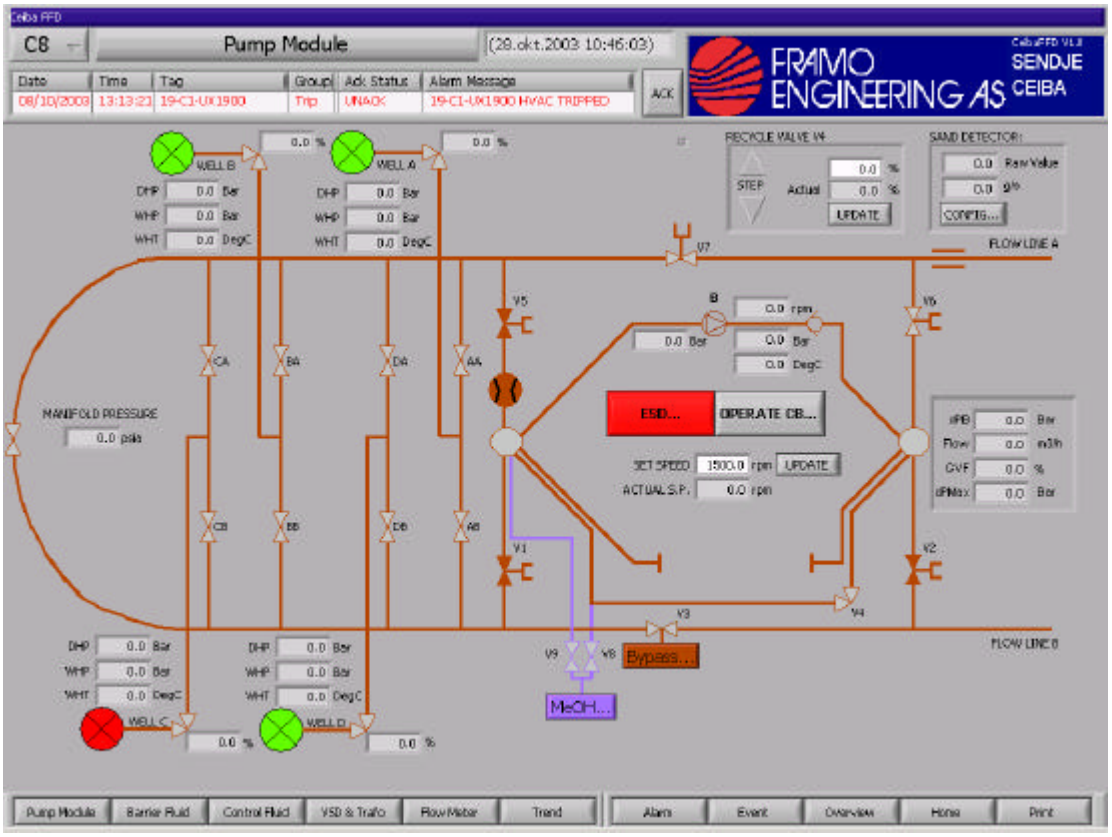


Figure 16-20. Pump Module C8.

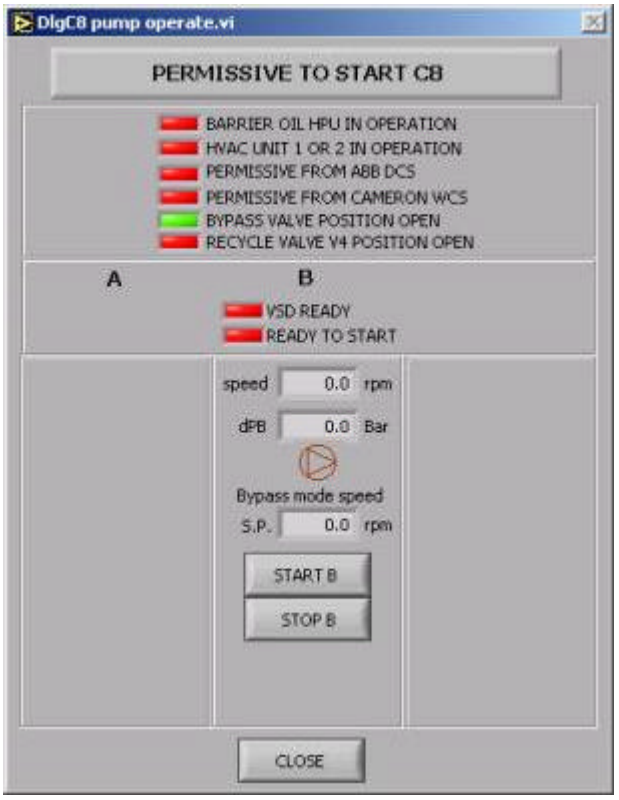


Figure 16-21. Operate Pop-up menu, Pump module C8.

Figure 16-22. Methanol injection valve pop-up menu, pump module C8.

Figure 16-23 By-pass valve pop-up menu, pump modulen C8.

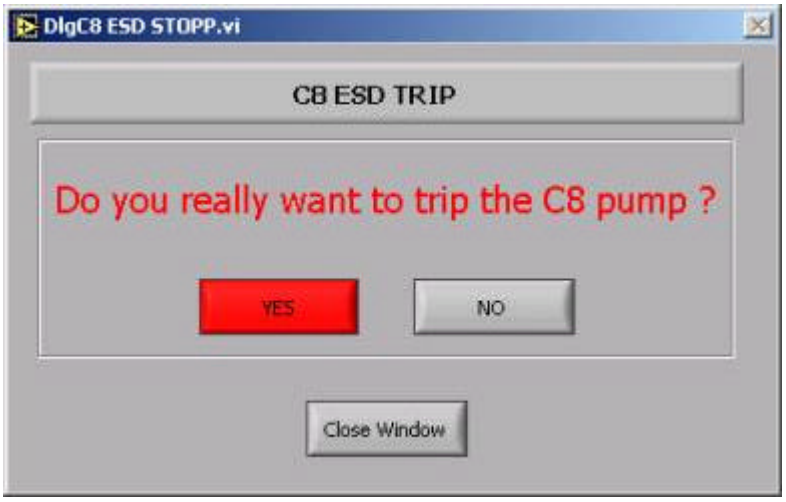


Figure 16-24. ESD pushbutton pop-up menu, pump module C8.

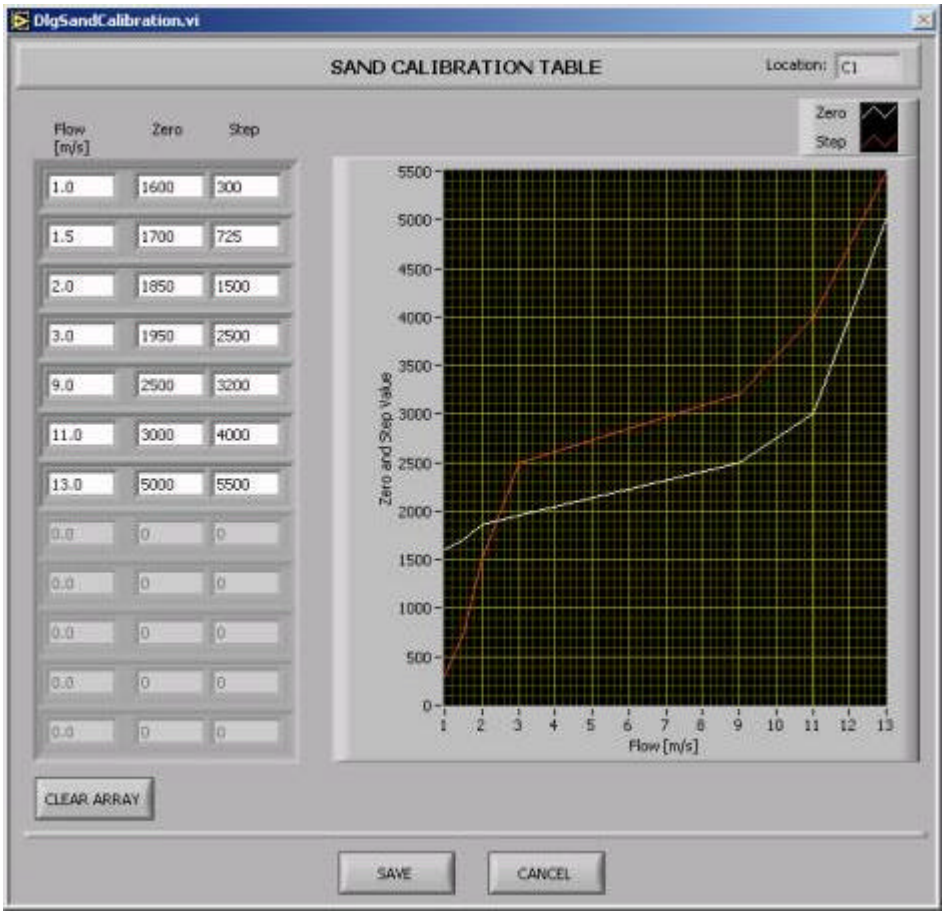


Figure 16-25. Clamp-On Sand Detector calibration table, pop-up menu pump module.

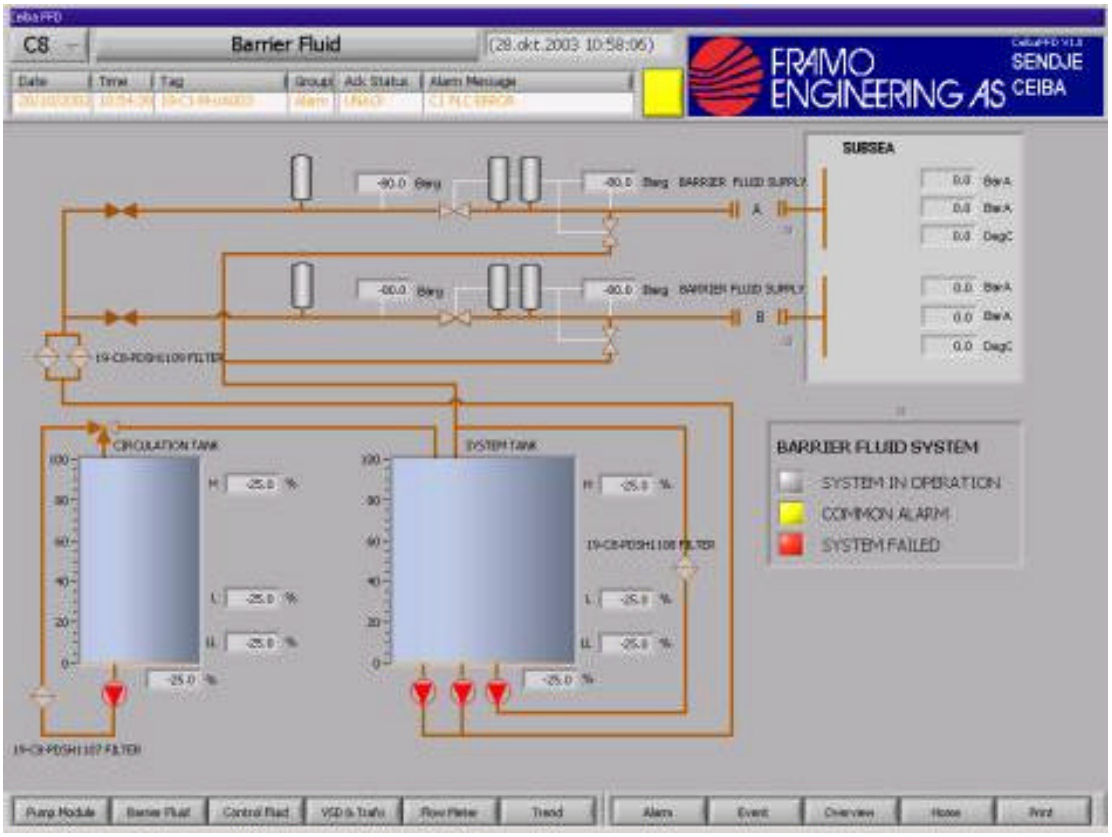


Figure 16-26. Barrier fluid system C8

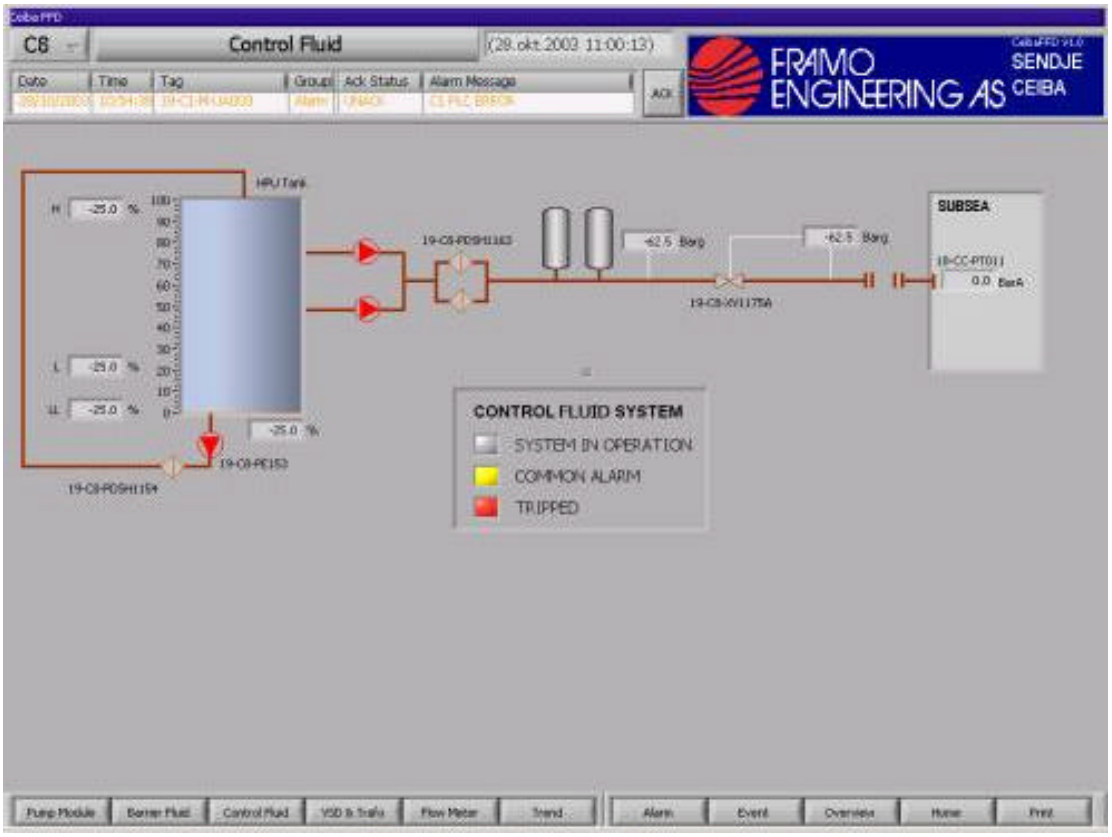


Figure 16-27. Control fluid system C8.

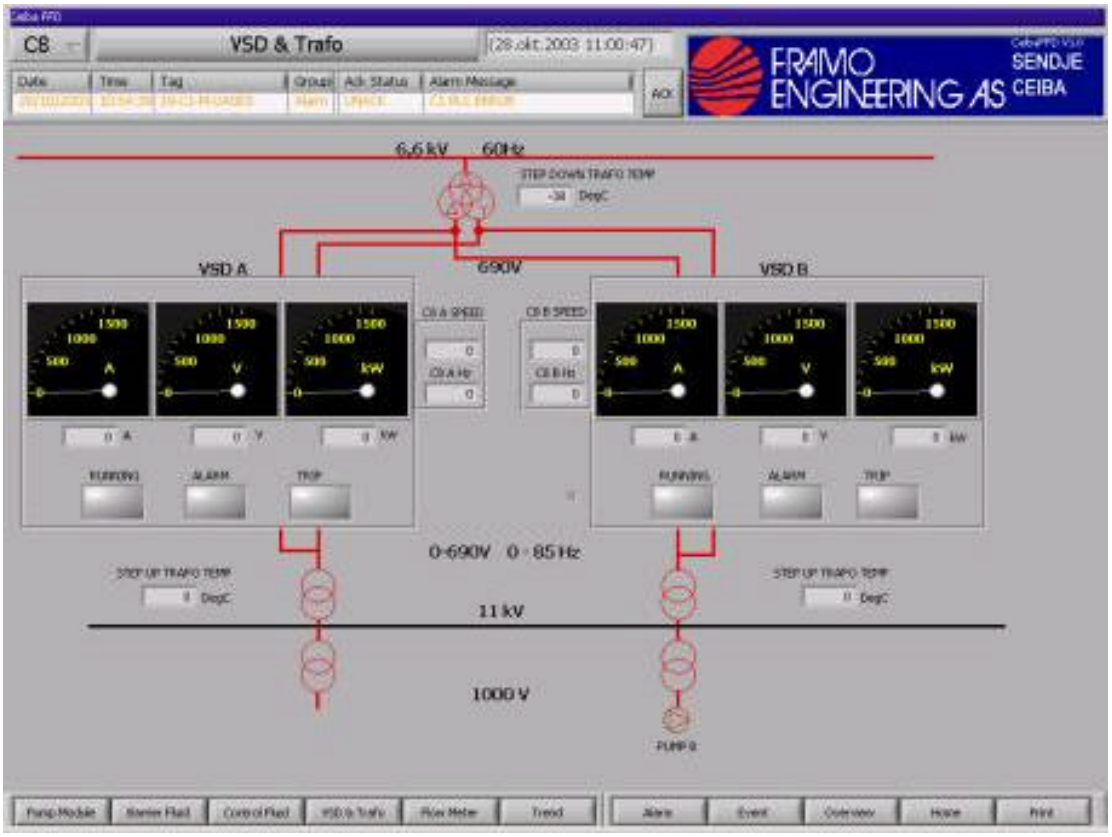


Figure 16-28. VSD & Trafo C8.

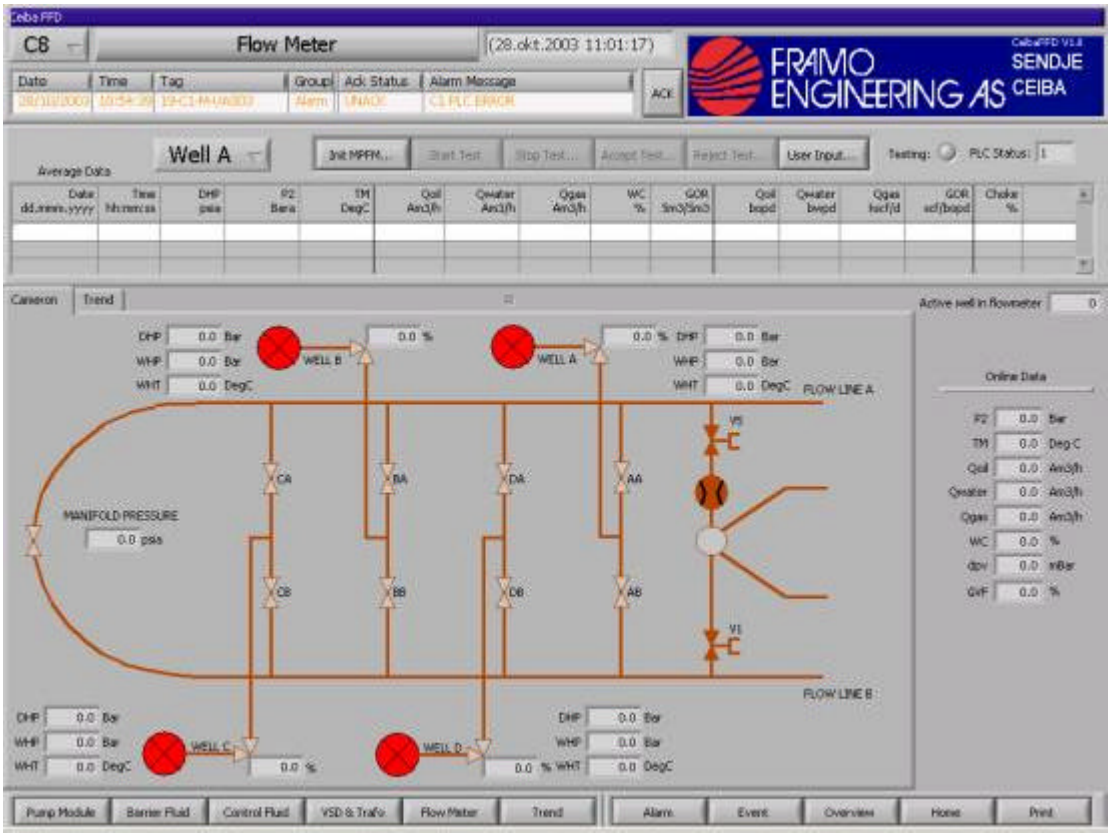


Figure 16-29. MPFM C8, Manifold layout.

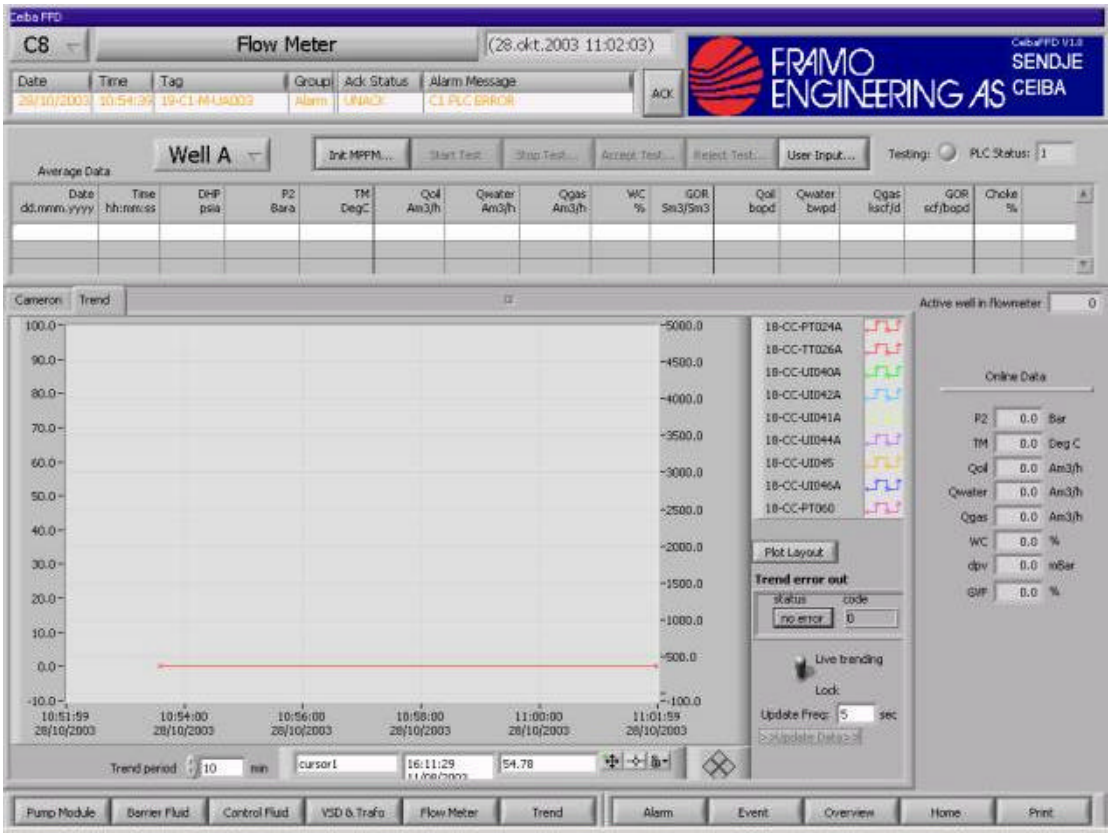


Figure 16-30. MPFM C8, Trend layout.

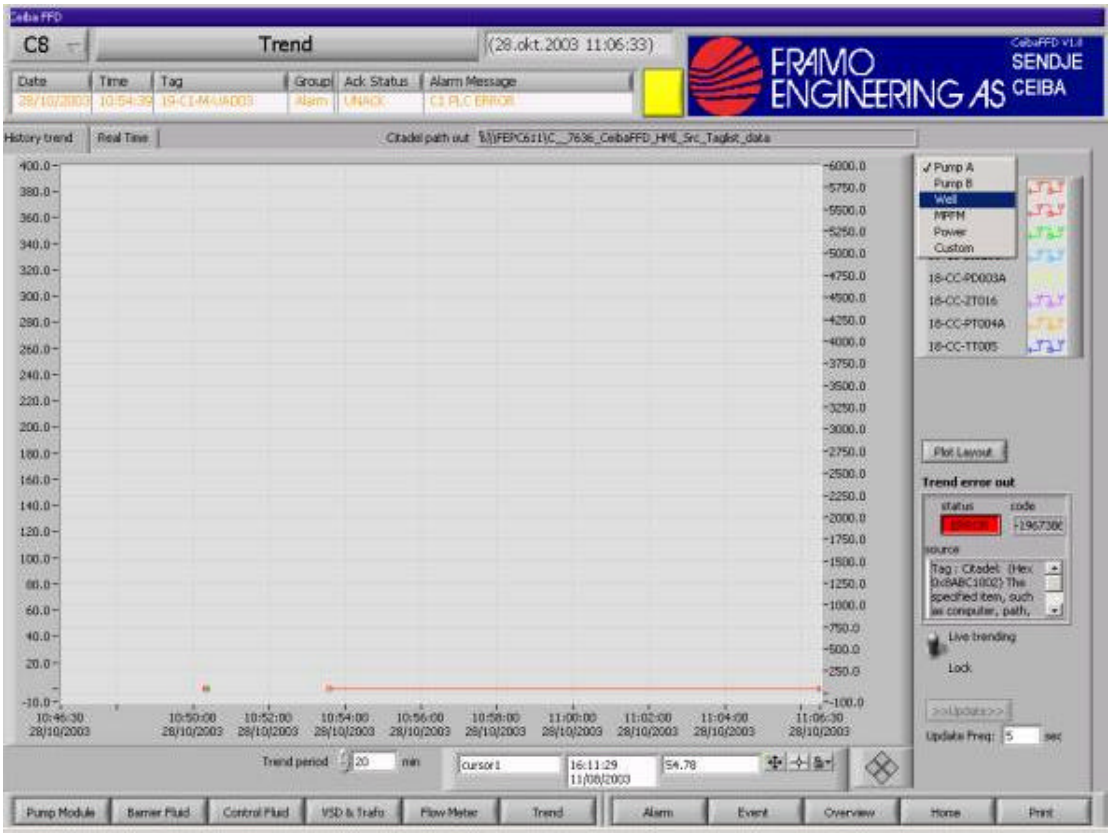


Figure 16-31. Trend, Historical trend.

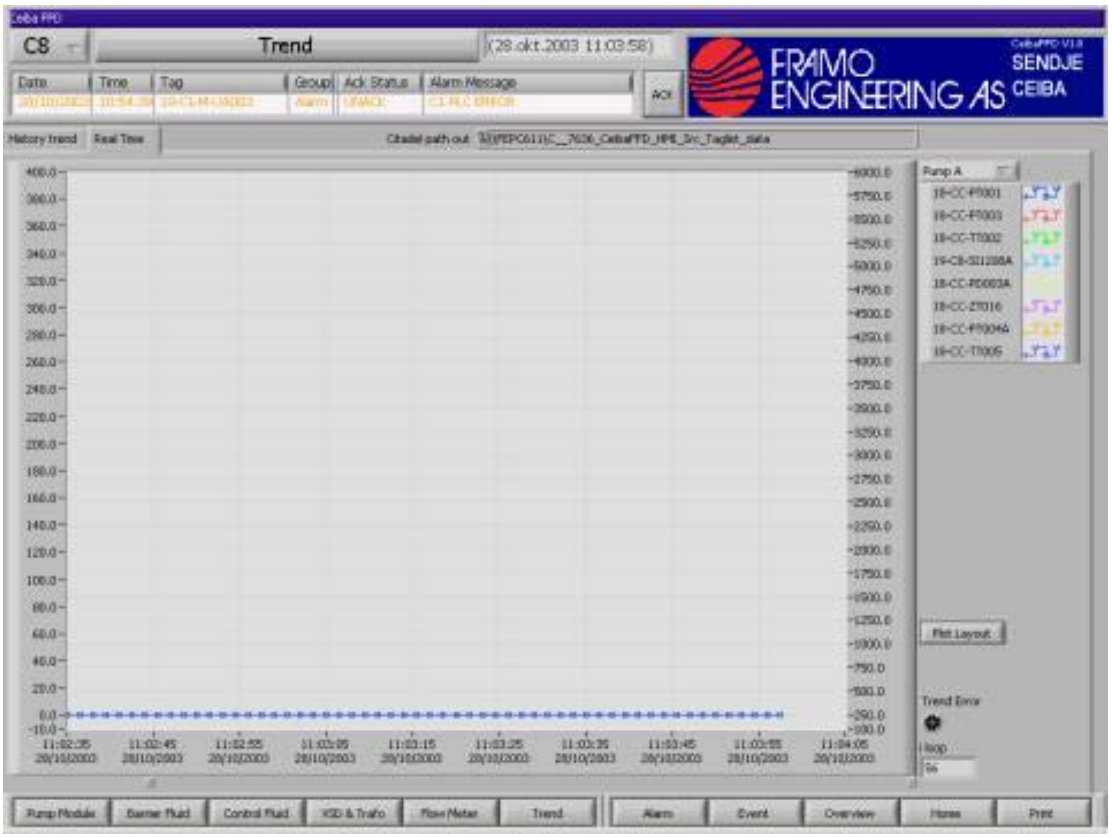


Figure 16-32 Trend, Real time.

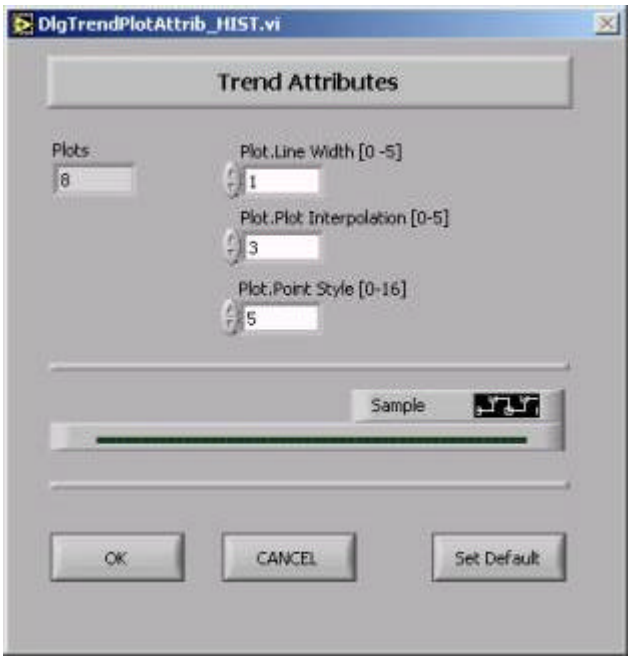


Figure 16-33. Trend configurations, attributes.

Figure 16-34. Trend Tag Configurations, Custom menu.

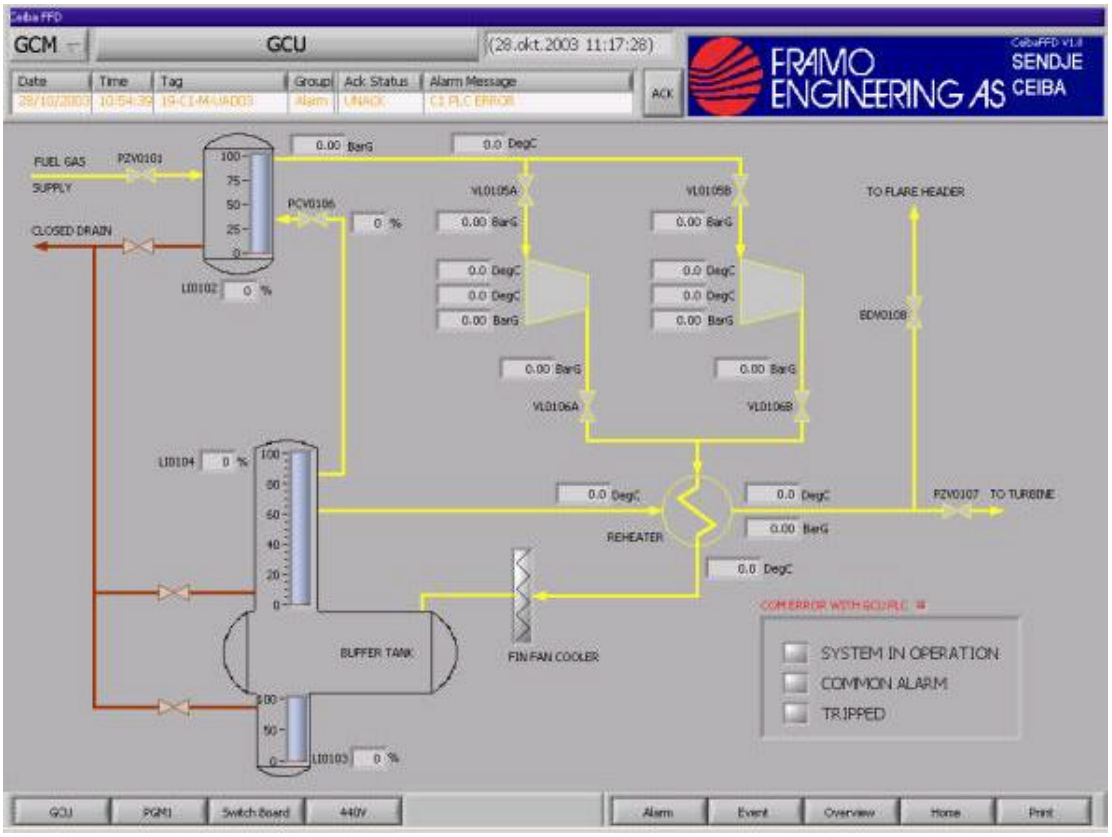


Figure 16-35. GCU.

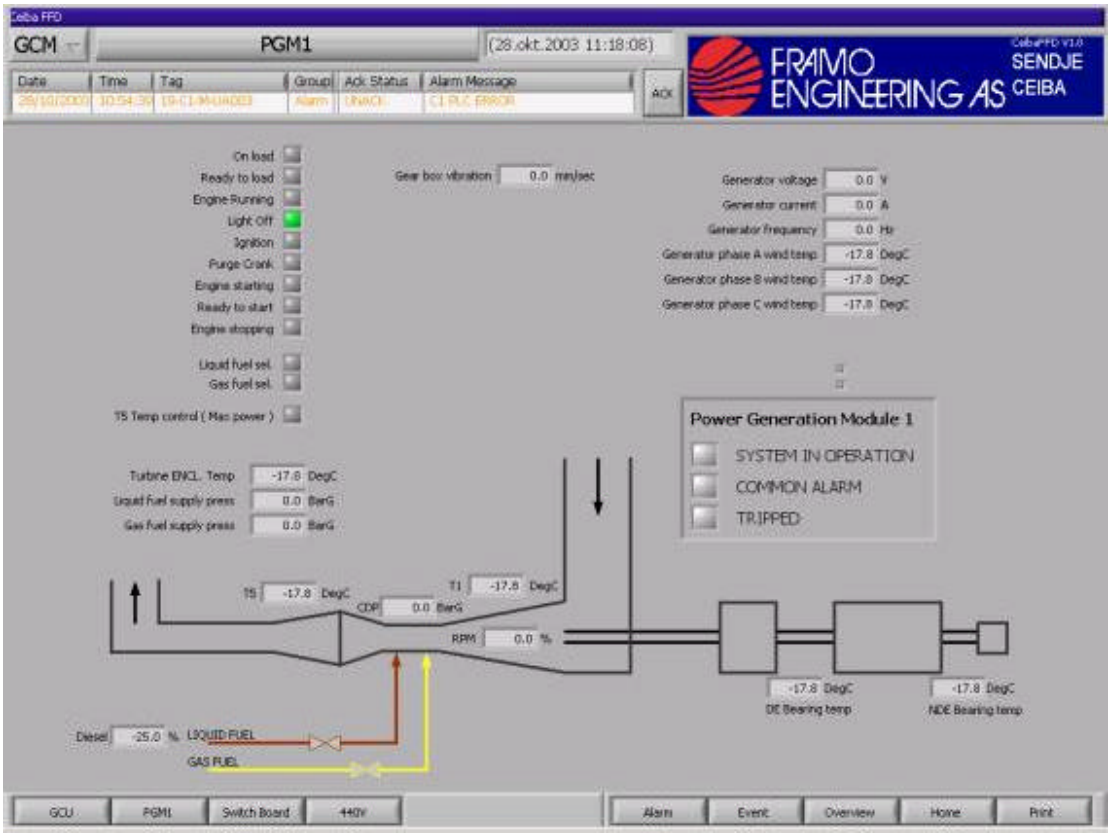


Figure 16-36. PGM1

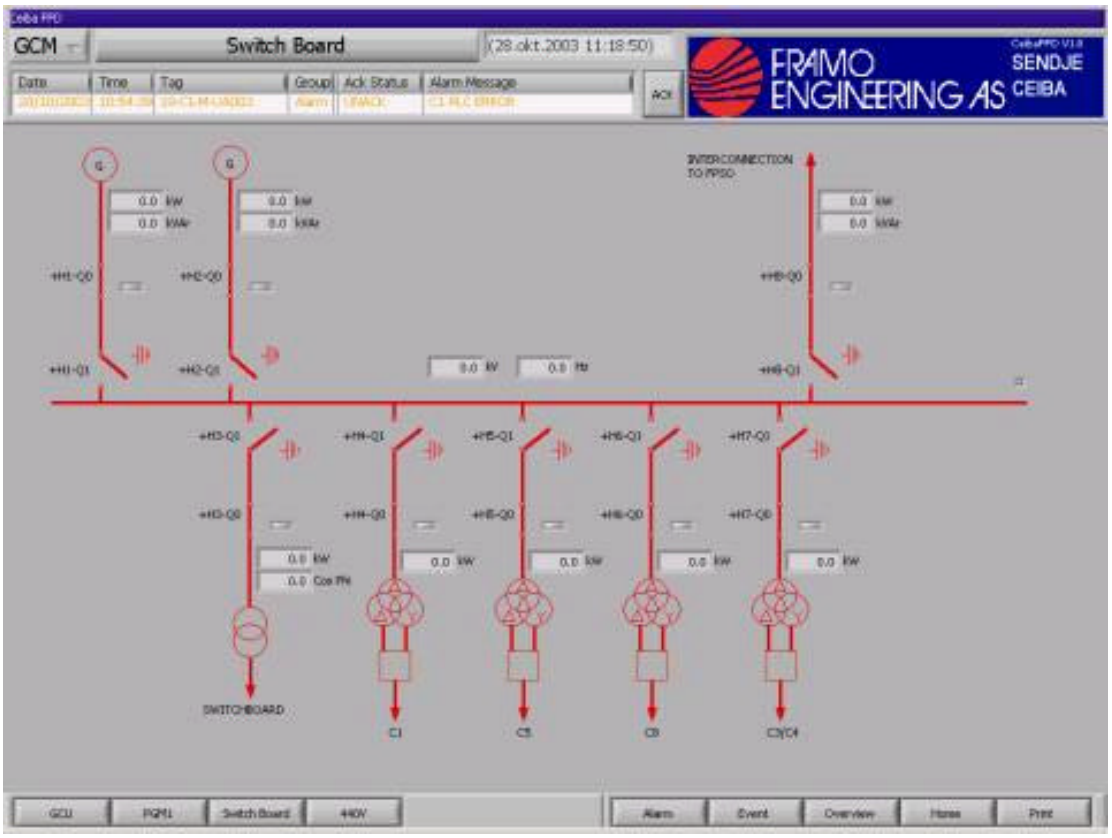


Figure 16-37. High Voltage Switch Board.

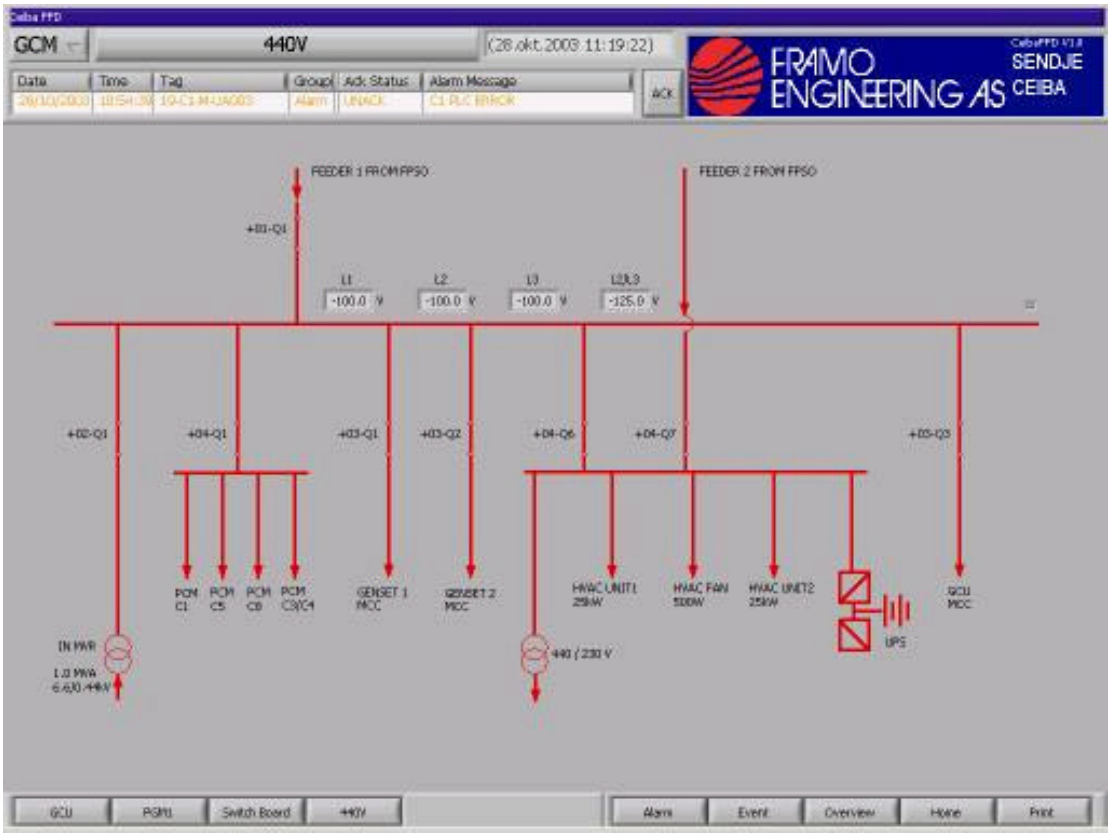


Figure 16-38. 400 Voltage distribution

17 APPENDIX B - CHECK-LIST BARRIER FLUID SYSTEM

#	EQUIPMENT/COMPONENTS	TAG NO 19-/LOCATION	VERIFICATION	NOTE
1	Shipboard supply lines A & B to C1, C5 and CC.		Connected and in good condition	
2	System commissioning		Terminated	System is ready
3	Hydr. oil on system tank and circ.tank	-CX-TB 100 -CX-TB 101	Required oil is Shell Morlina VG5	Sufficient level in the tanks
4	Oil cleanliness		NAS 1638 class 6 or better	
5	Accumulators	-CX-VX140A -CX-VX141A -CX-VX142A -CX-VX140B -CX-VX141B -CX-VX142B		
6	Manual isolation valves on accumulator oil inlet	-CX-HV130A -CX-HV135A -CX-HV143A -CX-HV130B -CX-HV135B -CX-HV143B	Locked open	
7	Manual isolation/drain valves on accumulators	-CX-HV136A -CX-HV144A -CX-HV145A -CX-HV136B -CX-HV144B -CX-HV145B	Locked closed	No tag ID on these valves
8	Pressure safety valves, barrier oil supply lines	-CX-PSV138A -CX-PSV138B		
9	Pressure safety valves, barrier oil supply pumps	-CX-PSV126 -CX-PSV127		
10	Manual isolation valves of pressure safety valves, barrier oil supply line	-CX-HV137A -CX-HV139A -CX-HV137B -CX-HV139B	Locked open	
11	Manual isolation valves, barrier oil supply pumps on system tank (-C0 PB101/102)	Pump suction Pump discharge -CX-HV112 -CX-HV113	Locked open Locked open	No tag ID on suction valves
12	Manual isolation valves, barrier oil circulation pump, -CX-PB103, on system tank (-CX TB100)	Pump suction	Locked open	No tag ID on these valves
13	Manual isolation valves, barrier oil circulation pump -CX-PB104 on circulation tank -CX-TB101	Pump suction	Locked open	No tag ID on these valves
14	Manual drain valves on HPU tank TB 100 & 101	Tank bottom	Locked closed	No tag ID on these valves

#	EQUIPMENT/COMPONENTS	TAG NO 19-/LOCATION	VERIFICATION	NOTE
15	High pressure dual filter w/press.diff.transmitter	-CX-FF128 -CX-PDSH 1109	Selector handle to point in direction of filter to operate. No PDA indication.	No diff.press alarm trigged
16	Manual isolation valve on test/sample point at high pressure filter outlet	-CX HV129	Closed	
17	Low pressure single filter on circulation tank circ. circuit	-CX FF122 -CX PDSH 1107	No PDA indication	No diff.press alarm trigged
18	Manual isolation valve on test/sample point at low pressure filter inlet	-CX HV124	Closed	
19	3-way valve (circulation/filling) on barrier oil circulation loop located on circulation tank	-CX HV123	Handle in poistion circulation	
20	Low pressure single filter on system tank circulation circuit	-CX FF125 -CX PDSH1108	No PDA indication	No diff.press alarm trigged
21	Level glasses/transmitters on system and circulation tank	-CX LG1106/LT1106 -CX LG1105/LT1105	In operation and active. Isolation valves open	
22	Instruments/transmitters on barrier oil supply line (PI and PIT)	-CX PI1114A -CX PIT1110A -CX PIT1113A -CX PI1114B -CX PIT1110B -CX PIT1113B	Block & Bleed open on supply side. Drain is closed	
23	Solenoid valves on barrier oil supply lines	-CX XV 111A -CX XV 111B	Active	Fai-safe-closed
24	Solenoid valve on barrier oil supply line drain connection	-CX XV 112A -CX XV 112B	Active	
25	Air vent filter on circulation tank	-CX FF121	No red pop-up indication	System tank is vented into circ.tank
26	Isolation valves, A pump barrier oil supply branch	-CX HV131A -CX HV133A	Locked open	
27	Isolation valves, B pump barrier oil supply branch	-CX HV131B -CX HV133B	Locked open	

18 APPENDIX B - CHECK-LIST CONTROL FLUID HPU

#	EQUIPMENT/COMPONENTS	TAG NO 19-/LOCATION	VERIFICATION	NOTE
1	Shipboard supply lines CX	Control fluid	Connected and in good condition	
2	System commissioning		Terminated	
3	Oil tank	-CX TB150	OCEANIC HW 525	Sufficient level in tank
4	Oil cleanliness		NAS 1638 class 6 or better	
5	Accumulators	-CX VX170A -CX VX170B		
6	Manual isolation valves on accumulator oil inlet	-CX HV168 -CX HV169	Locked open	
7	Manual isolation/drain valves on accumulators		Locked closed	No tag ID on these valves
8	Pressure safety valves, supply line	-CX PSV164A -CX PSV164B		
9	Pressure safety valves, supply pumps	-CX PSV160 -CX PSV161		
10	Manual isolation valves of pressure safety valves, supply line	-CX HV165 -CX HV166	Locked open	
11	Manual isolation valves, oil supply pumps on system tank (-CX PB151/152)	Pump suction Pump discharge -CX HV180 -CX HV181	Locked open Locked open	No tag ID on these valves
12	Manual bleed valves, oil supply pumps on system tank. (-CX PB151/152)	Pump discharge	Closed	No tag ID on these valves
13	Manual isolation valves, circulation pump (-C0 PB153)	Pump suction	Locked open	No tag ID on these valves
14	Manual drain valves on HPU tank TB150	Tank bottom	Locked closed	No tag ID on these valves
15	High pressure oil dual filter w/press.diff. transmitter	-CX FF162 -CX PDSH 1163	Selector handle to point in direction of filter to operate. No PDA indication	No diff.press. alarm trigged
17	Low pressure single filter on fluid tank circ. circuit	-CX FF156 -CX PDSH1154	No PDA indication	No diff.press. alarm trigged
18	Level glass/transmitter on tank	-CX LG1155/LT1155	In operation and active. Isolation valves open	
19	Instruments/transmitters on valve control supply lines (PIT)	-CXPIT1176A -CXPIT1176B	Block&Bleed open on supply side. Drain is closed.	
20	Instruments/transmitters on valve control common supply (PI and PIT)	-CX PI1159 -CX PIT1171	Block&Bleed open on supply side. Drain is closed.	
21	Solenoid valves on valve control supply lines	-CX XV1175A -CX XV1175B	Active	Fail-Safe-Open
22	Manual isolation valves on valve control oil drain lines	-CX HV1177A -CX HV1177B	Locked closed	
23	Manual isolation valves on valve control supply lines	-CX HV174A -CX HV174B	Locked open Locked closed	

#	EQUIPMENT/COMPONENTS	TAG NO 19-/LOCATION	VERIFICATION	NOTE
		Module shipboard interface		
24	Air vent filter on fluid tank	-CX FF157	No red pop-up indication	